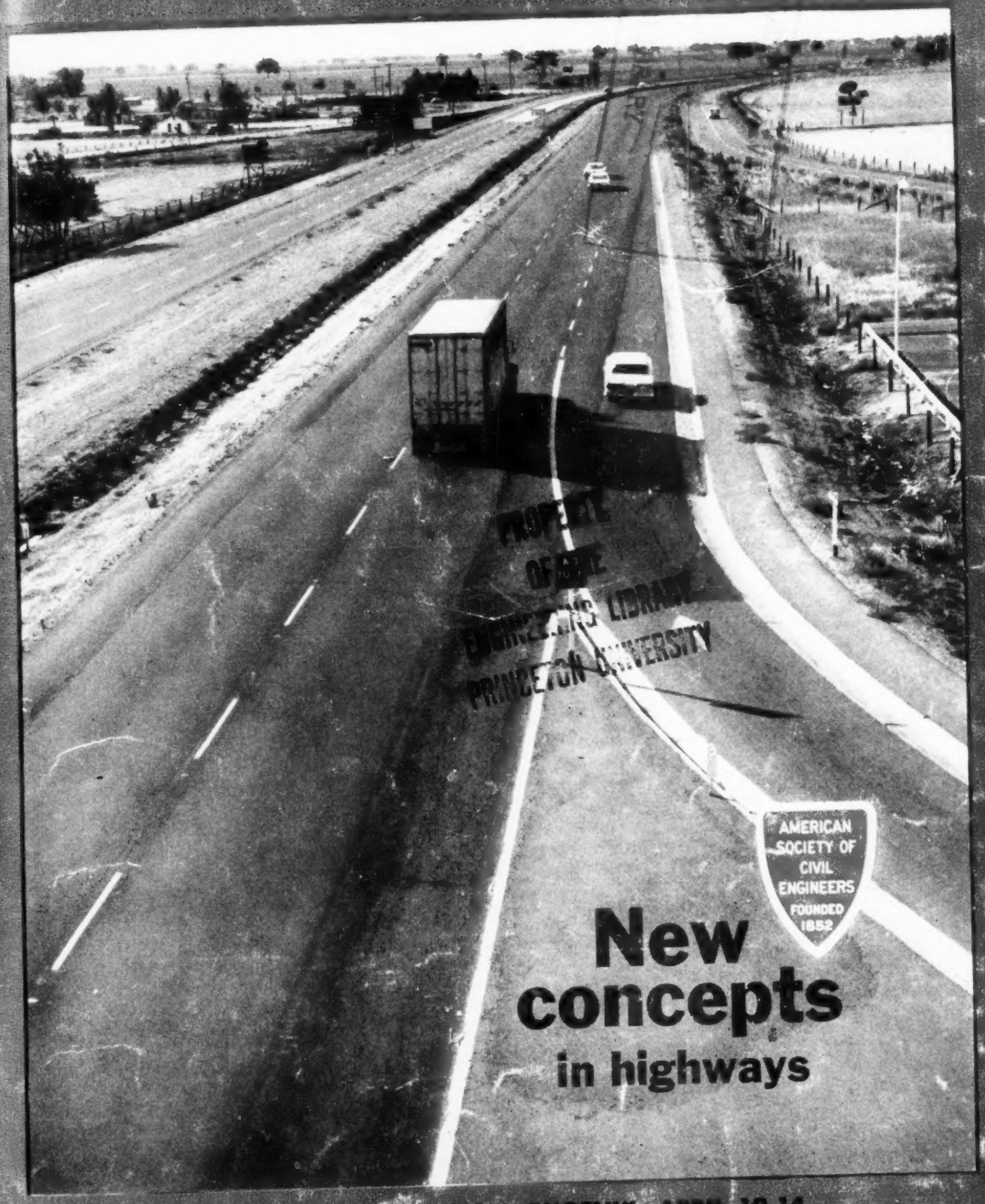
CIVIL ENGINEERING

THE MAGAZINE OF ENGINEERED CONSTRUCTION • JANUARY 1961



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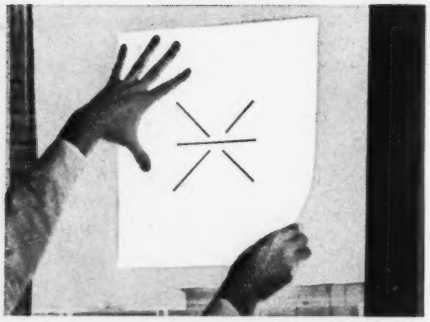

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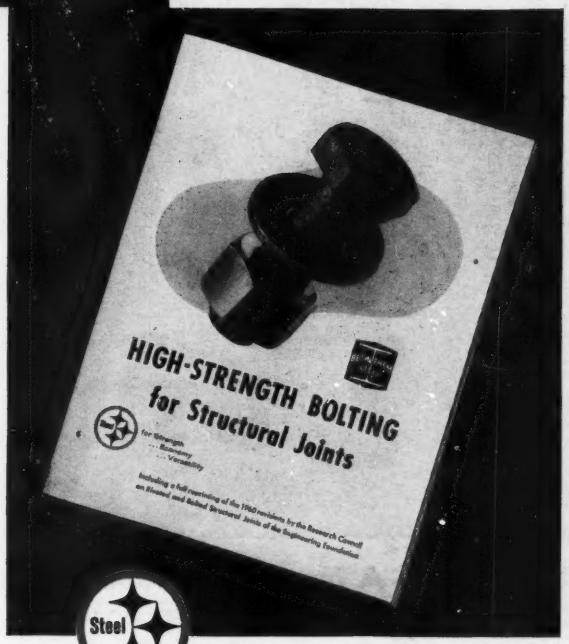

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THE MAGAZINE OF ENGINEERED CONSTRUCTION

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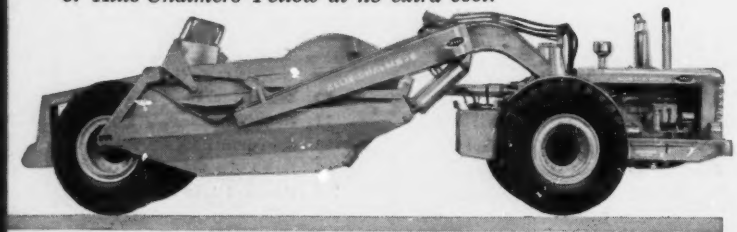

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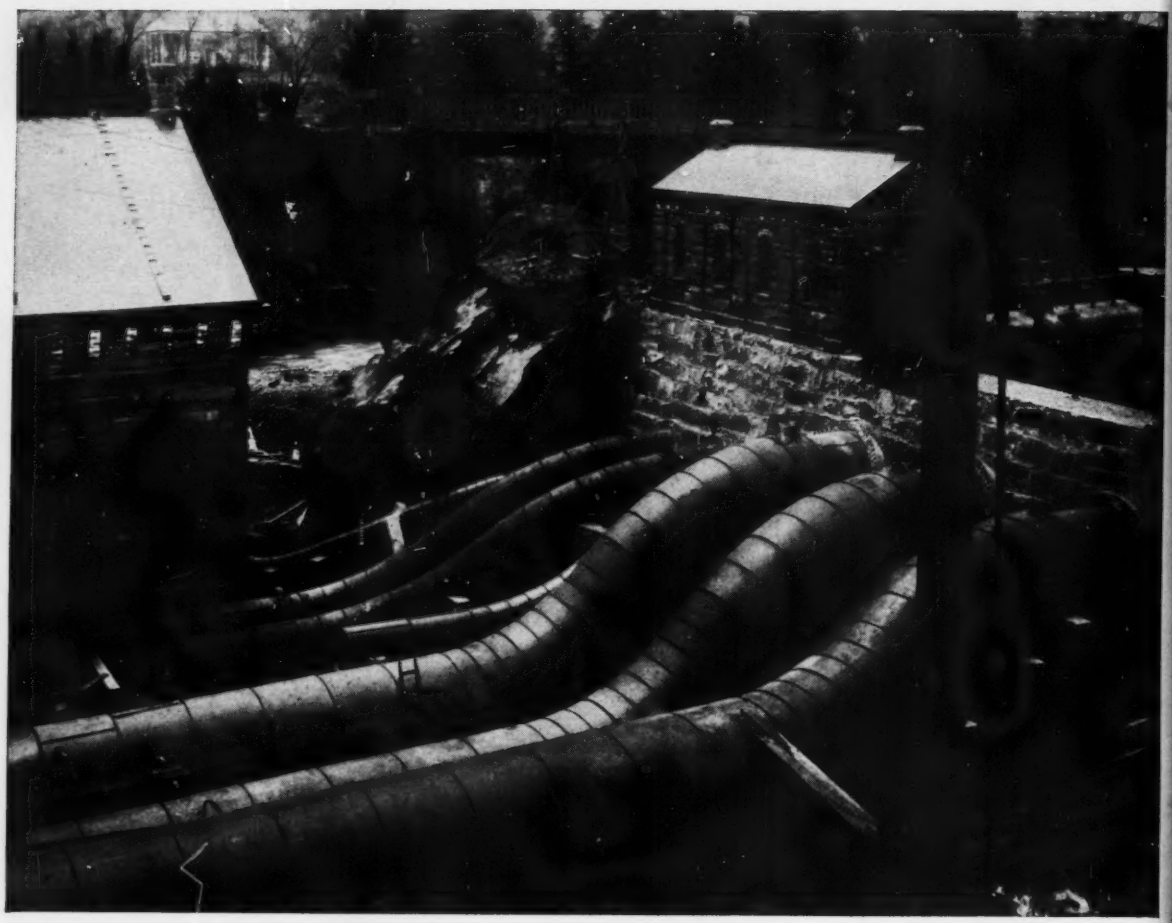

Steel pipe installed in 1899 is still on the job

In 1921 a washout completely undermined this thin-walled (¼-in.) 30-in. main in Paterson. It held! And it's still going strong today.

OVER sixty years ago, when a predecessor of the Passaic Valley Water Commission built a pumping station at Little Falls, New Jersey, they installed the riveted steel pipe shown above. It includes three 12-ft penstocks, and one 36-in., one 48-in., and two 66-in. supply mains.

In 1903 a filtration plant (the world's first large-size rapid sand filter system) was added. Since that time the major portion of the water supply for the communities of Paterson, Passaic, and Clifton has passed through these pipes. With time out for cleaning and re-lining two of the penstocks, the lines have been in constant service for over sixty years.

Beginning in 1894, over thirty miles of large-diameter steel mains have been installed in the area served by the Passaic Valley Water Commission, and all are in service today.

Isn't this persuasive evidence of the long service life of steel water mains?

For information about today's vastly improved steel pipe, please contact the Bethlehem sales office nearest you.

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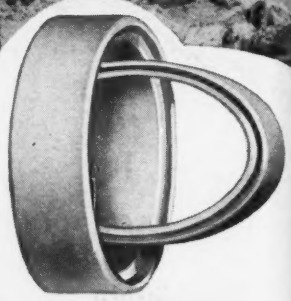

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Minimizes surface excavations, makes salvaging of old sewers easier

LO-HED® PIPE

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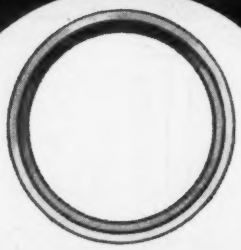

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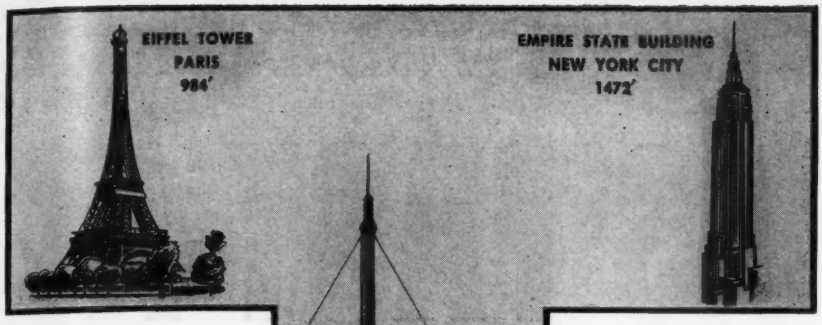
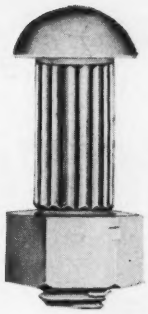




World's ALLEST Man-Made Structure

1,676' Tower KFVS-TV Cape Girardeau, Missouri

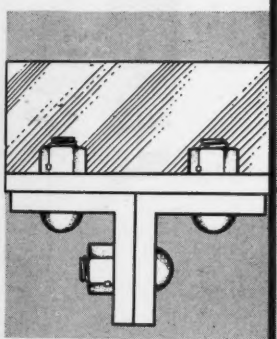
Constructed With ANCO Structural Rib Bolts And Lock Nuts

More than 2,000,000 people living in a 31,800 square mile area around Cape Girardeau, Missouri, are receiving television transmission from the tallest man-made structure in the world—the 1,676' tower designed and fabricated for KFVS-TV by Dresser-Ideco Company of Columbus, Ohio. *Every foot of this new tower is held together by ANCO Structural Rib Bolts and Lock Nuts.*

ANCO Structural Rib Bolts are an excellent choice for heavy-duty jobs like the Cape Girardeau Tower. This massive structure weighs 2,000,000 pounds and is braced by cables with a breaking strength of more than 375,000 pounds. Designed to withstand winds of over 100 miles per hour, the tower is crowned with an 81-foot, 5½-ton antenna, and is serviced by a passenger elevator which takes 25 minutes to reach the top. Tower legs are solid steel rods of 4" to 7½" diameter.

For the Cape Girardeau and other tall TV Towers, ANCO Structural Rib Bolts and Lock Nuts were chosen for speed, strength and safety. They can be installed by a single man using a hammer and wrench. In actual tests, a ⅝" diameter Structural Rib Bolt proved stronger than a ¾" rivet. They can't work loose, even under severe vibration and shock.

Available in black or galvanized finish to meet your requirements. Write today for samples, technical data and prices without obligation.



For more than 25 years, ANCO Lock Nuts have been first choice for constructing towers . . . for radio, television, high tension lines, microwave, radar antennas and reflectors. They are approved for all types of Federal, State and private projects.

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"'K&M' ASBESTOS-CEMENT

LAYS AS FAST AS

Assembling 16" "K&M" Asbestos-Cement Pressure Pipe by hand without the aid of a bar. The backhoe merely steadies and aligns the pipe. The easy, two-step operation consists of (1) lubricating the tapered end of the pipe, and (2) sliding pipe into coupling.

PRESSURE PIPE

A SHOVEL DIGS..."

G&B Construction, Inc., Youngstown, Ohio, installs 4½ miles of "K&M" Asbestos-Cement Pressure Pipe for the Austintown District of Mahoning County, Ohio

"You can lay 'K&M' Pipe as fast as a shovel can dig. There is nothing that will hold you back with this pipe. When you can lay a 16" water line, and it goes in as easy as an 8" water line, what more could you ask? They've got a good joint with that FLUID-TITE® Coupling . . . the pipe is wonderful to put together. Of all the 'K&M' Pipe we've laid, we never had a coupling break."

Those are the comments of Louis Gulfo, partner with Mike and James Bertilacci in G&B Construction, Inc. They installed "K&M" Asbestos-Cement Pressure Pipe in bitter cold, during February and March 1960. However, neither rain, snow, nor mud interrupts the installation of this modern pipe. The exclusive, patented "K&M" FLUID-TITE Coupling and the simple fitting procedures required make assembly easy.

Little or no maintenance will face Mahoning County, which built and will operate the system for a year, or the City of Youngstown, Ohio, which will then take it over. Being non-metallic, "K&M" Asbestos-Cement Pressure Pipe won't rot, corrode, or tuberculate, and is immune to electrolysis. The suppliers of this pipe were Trumbull Plumbing Supply Co., Warren and Youngstown, Ohio.

Now, in addition, you may use quality "K&M" Plastic Pressure Pipe in the same system with "K&M" Asbestos-Cement Pipe, if desired.

Write today for more information on "K&M" Asbestos-Cement Pressure Pipe to: Keasbey & Mattison Company, Ambler, Penna. Dept. P-1511.

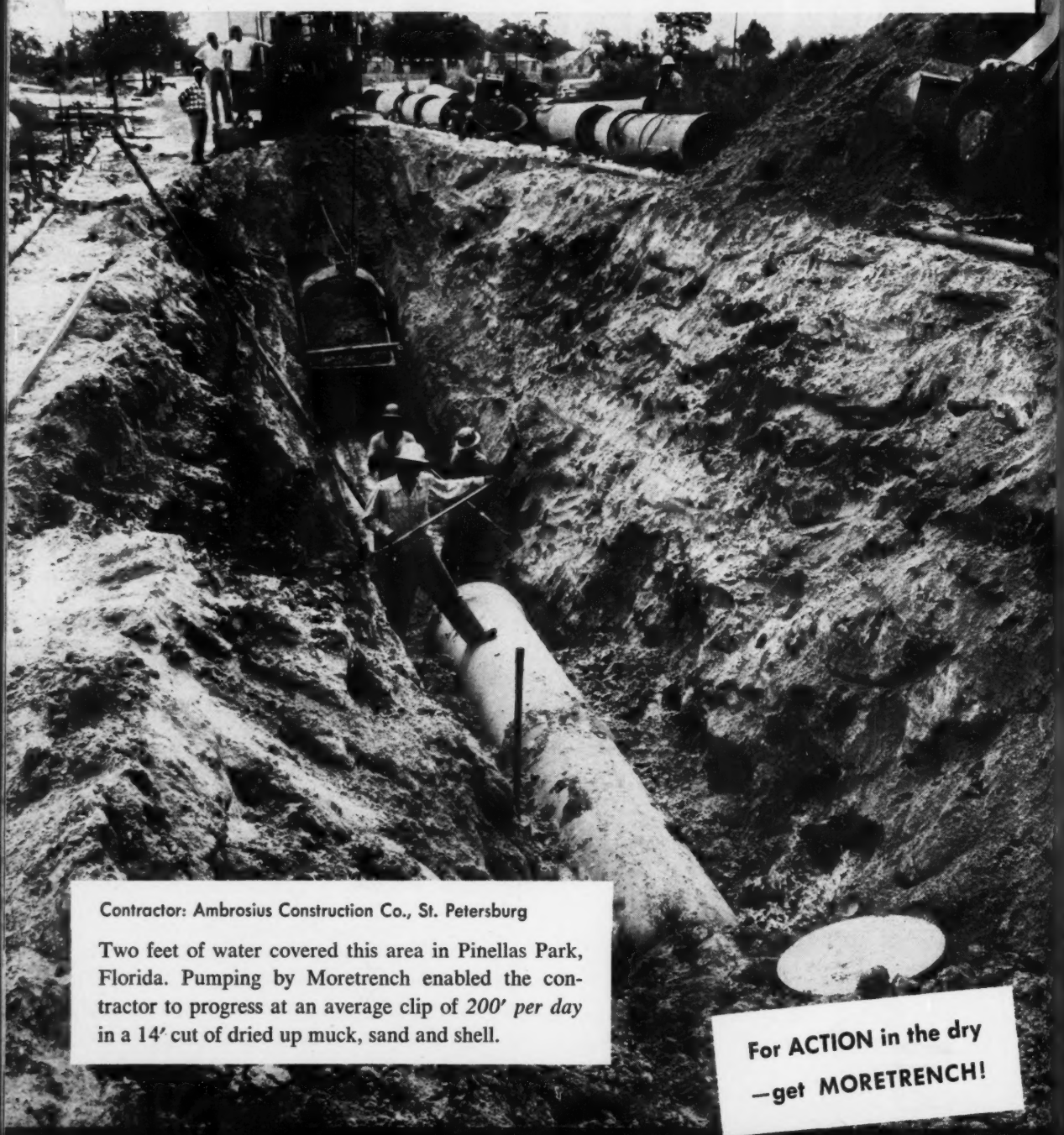
K·M BEST IN ASBESTOS

Keasbey & Mattison at Ambler

Left to right: Louis Gulfo, G&B Construction, Inc.; Dale MacCleary, sales manager, Trumbull Plumbing Supply Co.; James Bertilacci, G&B Construction, Inc., Burke Lyden, Asst. Chief Engineer, Youngstown, Water Dept., Jim Bisciglia, Asst. Engineer, Mahoning County, and J. Henry Painter, Trumbull Supply Company.

3 miles of 16" "K&M" Asbestos-Cement Pressure Pipe were installed. Here, we see it ready for installation along Webb Road, in Austintown Township. In branching from the 16" water line, Mahoning County used 1 mile of 12" "K&M" Asbestos-Cement Pressure Pipe and ½ mile of 8" "K&M" Asbestos-Cement Pressure Pipe. Specifications call for 90 lbs. pressure when line is in operation serving 16,000 residents.

WET SWAMP BECOMES DRY SEWER
VIA MORETRENCH WELLPOINTS



Contractor: Ambrosius Construction Co., St. Petersburg

Two feet of water covered this area in Pinellas Park, Florida. Pumping by Moretrench enabled the contractor to progress at an average clip of *200′ per day* in a 14′ cut of dried up muck, sand and shell.

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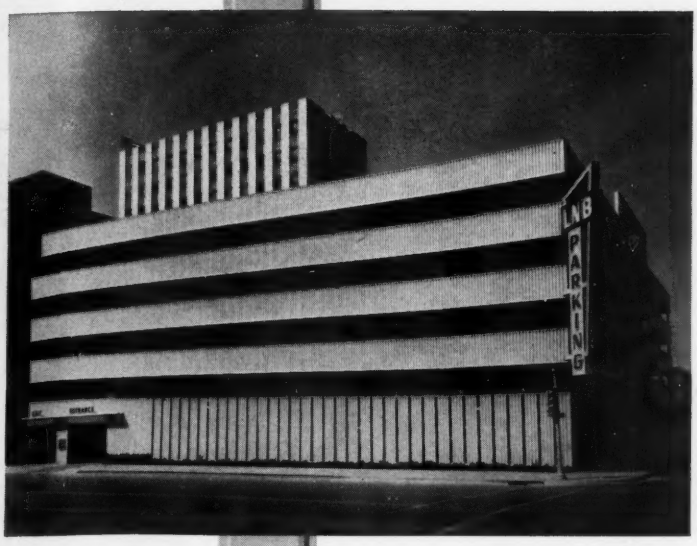

From pavement to paying space in only five months ...with STEEL

STEEL pays off sooner.

Take the case of the 5½ deck, 262-car parking facility built by the Lubbock National Bank in Texas, for example.

Steelwork was completed in just 16 working days, and only five months after construction started, cars began to roll in. This is *three months faster* than a nearby parking deck constructed of concrete.

Here's what this meant to the owner in additional income — income which could *never* have been realized if the parking deck had not been ready three months earlier.

Extra rental income for the owner:

1 month earlier completion — $4490

2 months earlier completion — $8980

3 months earlier completion — $13,470

Building with steel always pays off—and not just in income. Steel's other payoffs include lower construction costs and larger clear-span areas.

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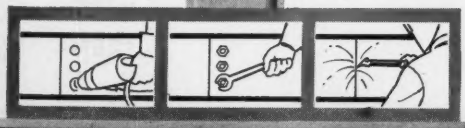
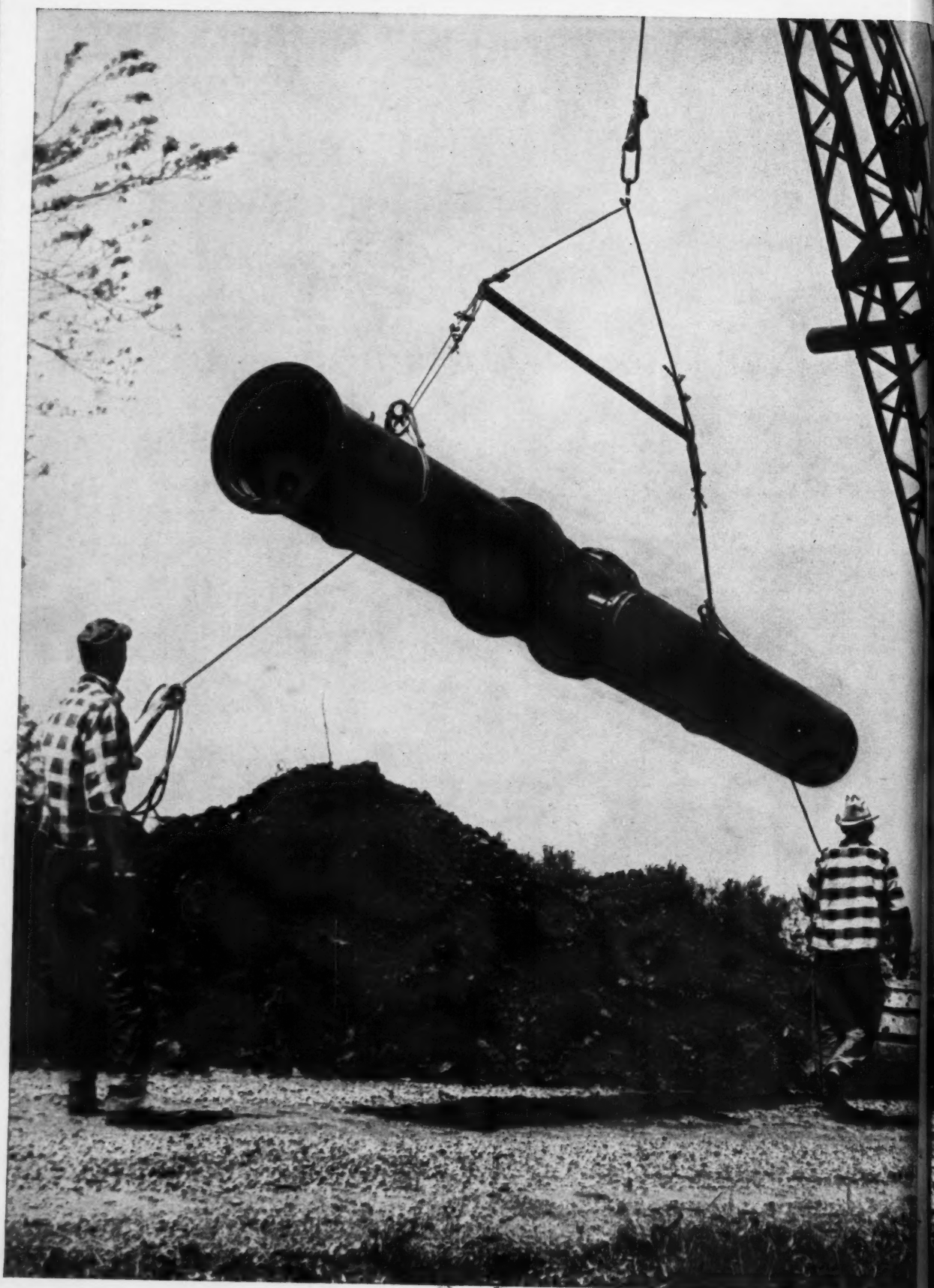


Steel *Steel* **STANDS** *for the future* AISC



PIPE THAT SHOULDERS A HEAVY LOAD WITHOUT SHOWING ITS AGE

Recently installed in a town in Illinois, this cast iron pipe water supply system now serves a large industrial area.

Besides the internal pressure of supplying the heavy daily demand, there is a heavy load overhead, too. The industrial area is a packaging and distribution center. Large numbers of fully loaded rail cars and trucks come and go every day.

As far as the cast iron pipe is concerned, this is all in a day's work.

Cast iron pipe shoulders heavy loads—interior and exterior—year after year; performs efficiently for a century or more.

And it always delivers a full flow of water.

Advertising campaign from Cast Iron Pipe Research Association shoulders a heavy load, too!

For years the Cast Iron Pipe Research Association has attacked the water problem nationally; now, in addition, it is undertaking a new campaign to combat this crisis on a local level. Car cards, speeches, radio spots, newspaper ads, mailing pieces—everything will be included. If your town's problem is apathy or a growing water shortage, we may be able to help. For complete details, write to the Cast Iron Pipe Research Association today!

CAST IRON PIPE RESEARCH ASSOCIATION,
Thos. F. Wolfe, Managing Director,
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THE MARK OF THE 100-YEAR PIPE

You own *FULL-POWER* ... *with "LIVE-TRACK"*

"Live-track" Planet Power-steering eliminates load-limiting "dead-track drag!" The TD-25 pushes or pulls the same king-size loads on turn or straightaway! On-the-go Hi-Lo power-shifting ends "gear-shift lag!" The "25" gives you instant, *up-or-down* matching of power to condition. *You turn with the dozer fully loaded, without spillage — do constant contact push-loading applying full power, getting full speed, without mauling the scraper!*

Only the "25" gives you the wallop of the International DT-817 engine — 230 turbocharged Diesel hp — to eliminate "slow-motion" lug-downs, even at high altitudes. For full performance under slam-bang conditions, the "25" has the super undercarriage strength of double-box-beam, precision-welded track frames!

No wonder owner after owner reports that 230-hp "25's" outwork king-sized clutch-steered crawlers, up to 50%! Prove to yourself what it means to own the capacity-boosting advantages of full-power momentum — full time, as *standard equipment!* Let your International Construction Equipment Distributor demonstrate the TD-25!

momentum FULL-TIME

TD-25 performance!

Beat the benching capacity of clutch-steered crawlers 100-hp bigger! Simply shift the TD-25's bank-side track to high range—the outside track to low—for full-bite benching. No "bank-nosing"—no sluing—no "lever-fighting." The planet-drive "25" keeps itself "on course"!

This TD-25 removes over 60% more overburden for a quarry man than his formerly-owned king-size clutch-steered crawler. Reasons: full-time "live-track" Planet Power-steering ends load-spilling "dead-track drag"—and the TD-25's high reverse of 7.5 mph cuts his dozer cycle time by more than 10%!

With on-the-go Hi-Lo power-shifting, you shift down to dig hard materials—shift up to "run" with the load. Hi-Lo power-shifting makes the TD-25 the industry's only 4-speed torque-converter crawler, and the only one with load-matching efficiency-range control. Only simplified TD-25 planetary design is engineered and located to give you "live-track" power-steering and on-the-go power-shifting!

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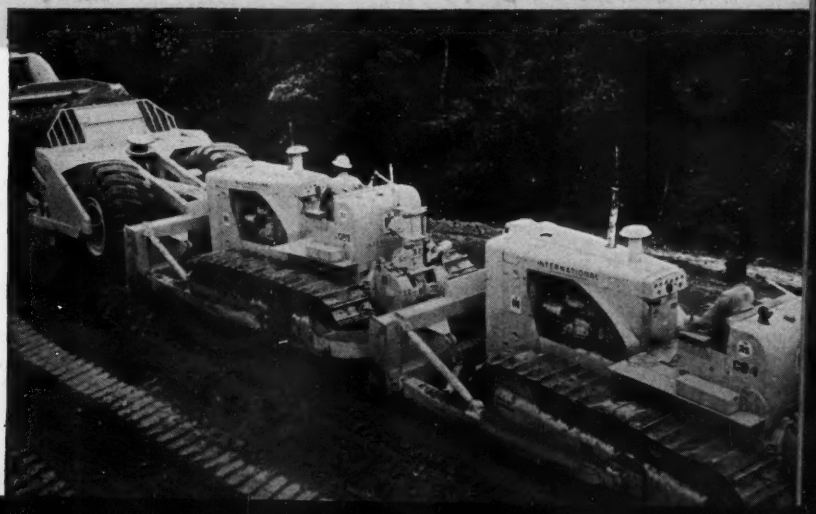
You speed up all four steps of the push-loading cycle with the torque-converter TD-25. (1) You power-shift down and use decelerator to get feather-touch contact; (2) power-shift either track up or down to keep solid push-block contact on curves; (3) power-shift up, on-the-go, for gear-higher kick-outs; (4) with 7.5 mph reverse, reposition faster than other rigs!



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The Motor City's New Convention Facility Stands On RAYMOND Foundations

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Rising proudly on a foundation by Raymond, Detroit's new Cobo Hall completes the vast complex that is the city's Civic Center. With the new City-County Building and the Ford Auditorium (both also on Raymond foundations), Cobo Hall furnishes the ample convention facilities that have been so sorely needed in this booming city. Including 1,632,990 square feet of usable space and room for 12,500 people at meetings and other functions, Cobo Hall will first play host this October to the National Automobile Show. *The Foundation:* 4,341 one hundred and eight foot pipe step-taper piles, for a total of 468,828 linear feet. Detroit's Cobo Hall is another new star in the galaxy of great public buildings large and small, supported by Raymond Foundations. So whatever your needs in foundation construction, give us a call. We can handle almost any problem with men, materiel, and experience—quickly and economically.

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NEWS OF MEMBERS

Conny Clyde Ricker, after 21 years of diversified experience in soil and water conservation problems, railway engineering, highway bridge contracting and engineering appraisal, retired on November 1 as area engineer of the U.S. Soil Conservation Service at Greencastle, Ind. Mr. Ricker, who has served the SCS since its inception in 1935, had a part in the pioneer work in the application of study and research methods to soil and water conservation problems and in the development of high technical standards by the group.

H. A. Sawyer, chairman of the board and president of the Lone Star Cement Company, New York, recently was elected chairman of the board of directors of the Portlant Cement Association, having served as a board member for five years. In 1925 Mr. Sawyer joined Lone Star as a service engineer, advancing through the ranks until 1952 when he was elected president, a director and a member of the firm's executive committee. He took on the additional post of chairman of the board in 1959. Mr. Sawyer is a past president of the Louisiana Section.

Robert D. James, until recently field service engineer in the New Orleans area for A. M. Byers Company, has been named manager of the firm's southwestern division, with headquarters in Houston, Tex. Before joining Byers Mr. James was associated with the Allis-Chalmers Manufacturing Company and the General Cable Corporation.

Joseph H. Ehlers is currently in Yemen as housing coordinator for the International Cooperation Administration. Mr. Ehlers is on loan for a six-month period from the Urban Renewal Administration where he is assistant commissioner for Technical Standards and Services at Washington, D. C., headquarters. The work of building shops, offices, adequate housing, a water and sewage system, and electric plant in Taiz is being done in connection with a road building project.

O. K. Albright, just completed a two-year assignment as director of the Design Division in the Eastern Atlantic and Mediterranean Area Public Works Office, U. S. Navy, at London, England. He returns to the Design Division of the Fourteenth Naval District Public Works Office at Pearl Harbor, where he was employed for four years prior to the London assignment.

Philip J. Baukol has returned to Canada to open an engineering office at 1200 West Pender Street, Vancouver, British Columbia, after many years as a consulting engineer in San Francisco. Mr. Baukol will continue to specialize in plant layout based on the clients' flowsheets and construction design engineering of processing plants.

John N. Beckley, since 1955 vice president and eastern district manager of the Austin Company, Cleveland, Ohio, recently took on new responsibilities as manager of the firm's international operations. Mr. Beckley, who is also a director of the company, will operate out of its New York offices at 600 Fifth Avenue.

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5
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Write today for complete Eagle information and name of your nearest dealer: Texas-Asiatic Import Company, 2127 Fort Worth Ave., Dallas 8, Texas.

Bedrich Fruhauf, consulting engineer of New York City, is going to Yugoslavia on a two-month assignment to advise its government on soil and foundation investigation. Mr. Fruhauf is one of the many United Nations technical assistant experts who go abroad every year to counsel governments requesting help in their programs of economic development.

Edwin F. Clark, 34-year veteran of the New York State Department of Public Works—most recently as director of Highway Programming and Control, returned, on October 6, to the Metropolitan New York area as director of Highway Transportation Studies after 14 years in the Albany office. From 1926 until 1946 Mr. Clark designed, constructed and programmed many of Long Island's main highways and parkways, including Southern State Parkway and Sunrise Highway.

Jerome Felcher has joined Farkas & Barron as an associate and project engineer in their New York office. Since graduating from Bucknell University in 1954, Mr. Felcher has been an associate of Robert Rosenwasser, of New York City.

R. L. Moore, formerly assistant chief of the engineering design division of the Aluminum Company of America's Alcoa Research Laboratories in New Kensington, Pa., is now division chief. For 14 years he served in Alcoa's physical testing division, transferring to the engineering design division in 1943, where he was named assistant division chief in 1951.

At the time of his recent retirement as chief of the Division of Sanitary Engineering of the Ohio Department of Health, Frederick H. Waring (right), was presented with a carved likeness of himself at a special luncheon of the Clay Sewer Pipe Association as a "tribute to his foresight, his work and his devotion to working out the problems of America's sanitation." Looking on are Barton A. Holl (left), president and general manager of the Logan Clay Products Company, and A. G. "Ted" Cochran, president of the Clay Sewer Pipe Association. Mr. Waring will continue as secretary of the eight-state Ohio River Valley Water Sanitation Commission.

(Continued on page 24)

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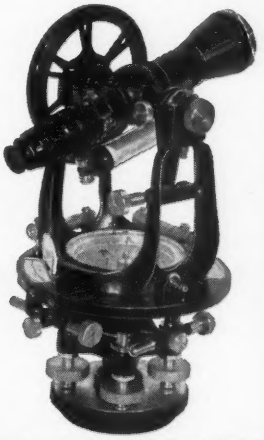

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Scientific readings ...recorded in the

Sponsored by the American Association of State Highway Officials (AASHO), this 27-million-dollar test will provide "statistically unassailable" facts on modern pavement design.

On November 30th traffic ended on five test loops at Ottawa, Illinois. 17 million miles of travel have been marked up. Vital data have been pouring in, useful new facts on pavement performance are evident.

The entire National Road Test project is the most scientific experiment ever carried out on highway pavements. Modern statistical techniques for test section layout assure the total reliability and impartiality of findings. The newest in instrumentation, recording and automatic data processing equipment are providing a tremendous volume of data—free from human reading and transcription error.

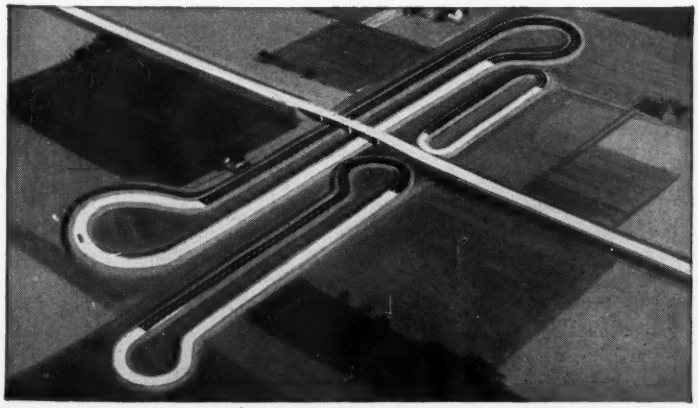
Electronic computers, of course, play a major role in data analysis. Some 100 programs have been written for the computers—so complicated that as much as 2 weeks were needed to set up a single program.

The final result—a storehouse of engineering information, the conclusive facts needed by every engineer, official and legislator to plan and build the most practical, efficient road system possible.

For Interstate highways, roads and streets of all classes, the National Road Test will prove the most significant test of pavement types of all time.

PORTLAND CEMENT ASSOCIATION *A national organization to improve and extend the uses of concrete*

by the millions National Road Test!



836 test sections—repeating nearly 200 different pavement combinations make up the loops. Over 1,100,000 load applications have been recorded.

The National Road Test is sponsored by the American Association of State Highway Officials.

Represented on the National Advisory Committee: American Association of State Highway Officials, American Automobile Association, American Trucking Associations, Inc., Asphalt Institute, Automobile Manufacturers Association, Automotive Safety Foundation, Bureau of Public Roads, Department of the Army, Highway Research Board, National Highway Users Conference, Portland Cement Association, Truck Trailer Manufacturers Association; the petroleum industry, state highway departments, the tire industry and universities.

Administered and directed by the Highway Research Board of the National Academy of Sciences—National Research Council.

Operated by a staff of engineering and technical specialists.

News of Members

(Continued from page 21)

Edgar W. Armstrong, in Federal service since 1930, retired recently as district engineer of the U.S. Bureau of Public Roads in Richmond, Va., to open an engineering office at 715 West Grace Street, Richmond. As district bridge engineer for the Bureau's South Carolina and Virginia districts, Mr. Armstrong constructed the bridges on the Blue Ridge Parkway.

Martin H. Blote, after 40 years of experience in the water development field at both Federal and state level, has opened a consulting office in the California Fruit Building in Sacramento to deal with water problems. Recently Mr. Blote retired from the Bureau of Reclamation. (October 1960 issue, page 25).

John Hugh Jones, as associate professor of highway engineering in the SEATO Graduate School of Engineering, will spend two years in Bangkok, Thailand, teaching highway and traffic engineering. His most recent position was as professor of civil engineering in the Technological Institute of Northwestern University, Evanston, Ill.

Floyd Peterson was recently named by President Eisenhower as his acting special assistant in public works planning. For the past five years Mr. Peterson has been a member of the White House staff, having previously served for 11 years as chief of the civil works branch in the Budget Bureau.

Thomas B. Powell, manager of the contractors equipment department of the Banks-Miller Supply Company, Huntington, W. Va., has been named a member of the city's new Urban Renewal Authority. Mr. Powell is assistant director of the county civil defense organization.

Edmund B. Besselievre has announced his resignation as manager of the industrial wastes division of Kaighin & Hughes, Inc., of Toledo, Ohio, and his removal to Dallas, Tex. In Dallas he will be available to assist in the solution of industrial waste problems.

Walter S. Hadala, former vice president of the Frederick T. Williams Company, Inc., which he joined in 1952, now heads the recently organized Hadala Construction Company. The new firm, located in Tonawanda, N. Y., will specialize in commercial, industrial and institutional buildings.

Clay P. Bedford, vice president of Kaiser Industries and general manager of the Kaiser Aircraft and Electronics Division, has been named chairman for the West Coast region of the Science Center Fund of Rensselaer Polytechnic Institute. In 1951 he was named special assistant to Charles E. Wilson, director of the Office of Defense Mobilization in Washington, serving in the same capacity the following year with Robert A. Lovett, Secretary of Defense.

Thomas J. Glynn, in his new position of assistant engineer of design in the Marine Terminals Design Division of the Port of New York Authority, will be responsible for coordinating division activities with those of other departments. Employed by the Port Authority since 1951, Mr. Glynn before his promotion was an engineering designer.

H. Velpeau Darling, who retired two years ago as chief engineer of the Corps of Engineers, Washington, D. C., is on a year's leave of absence from his current position as vice president of the Washington, D. C., firm of Transportation Consultants, Inc., to study water resources developments in Taiwan. Mr. Darling as project manager will head a team of eight international engineers under the Special Fund for which the United Nations is the executing agency.

Samuel I. Sachs, consulting engineer and attorney-at-law, is currently at work on the final draft of a new Philadelphia Building Code to replace the existing eleven-year-old code which does not include regulations covering the use of new materials and construction methods. In the past Mr. Sachs, has participated in the design of the Broad Street Subway and the Frankford Elevated system in Philadelphia.

Milton Alpern, after twelve years of combining an engineering practice with teaching work, has resigned from the civil engineering faculty at Cooper Union (New York) to devote full time to his structural and civil engineering practice. The firm's new offices are in the Wantagh Professional Building at 2079 Wantagh Avenue, Wantagh, N. Y.

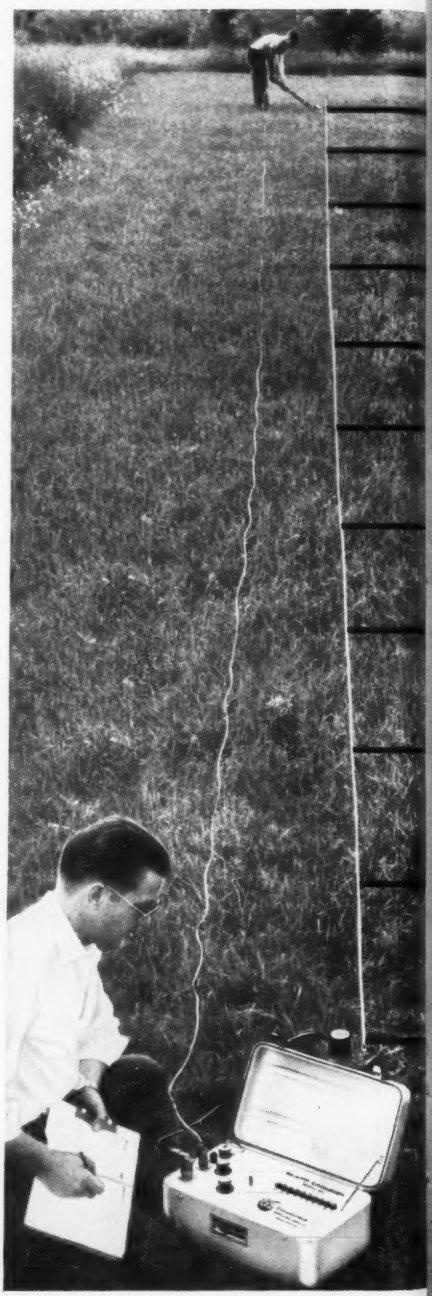
Certificate of Appreciation for Patriotic Civilian Service to the Department of the Army is accepted by Harrison P. Eddy, Jr., left, on behalf of the Boston consulting firm of Metcalf & Eddy for outstanding performance as architect-engineer for the Ballistic Missile Early Warning Systems at Thule, Greenland and Clear, Alaska. Lieutenant General E.C. Itschner presented the certificate during ceremonies on November 21.

(Continued on page 26)

SUBSURFACE EXPLORATION

Dirtmovers: Profit by complete, accurate pre-bid information on presence or absence of bedrock in cut areas and depth to bedrock; establish quantities and types of materials to be excavated; locate suitable borrow pits and location of water table; determine rippability of materials; aid scheduling of equipment during excavation work.

HOW YOU



Paving Contractors: Profit by establishing gravel deposits, volume and type, nearest to the work site.

Consulting Engineers: Profit by predesign subsurface information for buildings, bridges and highways.

Highway Engineers: Establish presence or absence of rock for highway design work; pre-bid classification of materials, volume of materials, subsurface structures.

Architects: Establish stability of subsurface materials and depths for all planning.

Quarry Producers: Profit by accurate information of location and size of aggregate deposits, amount of overburden.

Mining Engineers: For example; locate pre-glacial stream channels for placer exploration, determine bedrock depths.

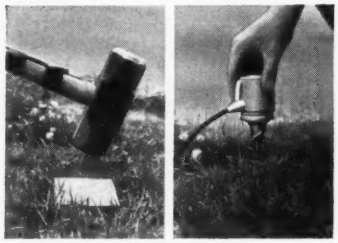
Bridge Builders: Economically establish stability of subsurface structure for foundations.

PROFIT WITH THE MD-1...

Today's profit squeeze and intense competition in the engineering and construction industry can make the MD-1 Engineering Seismograph the most important cost-saving tool you own.

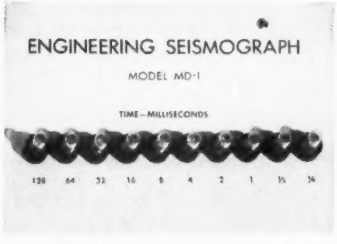
Why? Because daily throughout the world, MD-1 analyses of subsurface material conditions are being quickly converted into profits in the many ways listed above. Yet this vital tool requires no specialized training to operate. It develops accurate, reliable information in the simple manner shown here:

HAMMER PLUS GEOPHONE



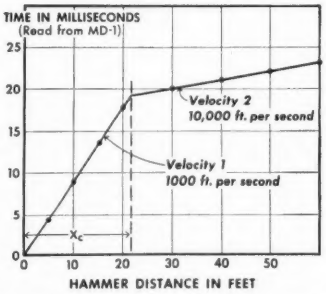
A sledge hammer is struck against a metal plate at known distances from the MD-1. As blow is struck, a switch closes on the hammer, starting the MD-1's electronic counter. The sound waves initiated by the blow are picked up by a geophone, also connected to the MD-1. The time of travel of the *first* or fastest sound wave to reach the geophone is read directly from the MD-1's electronic counter lights.

ELECTRONIC COUNTER



This travel time is determined by the depth and type of the material; the denser the material, the faster the sound waves travel.

PLOTTING MD-1 READINGS



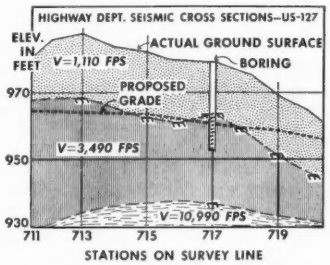
Recorded travel times are plotted on a graph. This time-distance curve represents the velocities of the materials encountered. These velocities indicate the types of materials and each break in the curve indicates a change in material.

DEPTH EQUATION

$$D = \frac{X_c}{2}\sqrt{\frac{V_2 - V_1}{V_2 + V_1}}$$

Using the above formula, the depth to denser materials or bedrock is provided. D is the depth, X_c is the hammer distance at which the velocity change occurs, V_1 is the velocity of the top material, and V_2 is the velocity of the second material. Depths to deeper layers are determined the same way.

SUBSURFACE PROFILE



The depths and materials are then marked on a profile map of the job so that subsurface conditions will be considered in the planning and bidding of the work.

PORTABILITY

Because of its small size and light weight, the MD-1 can easily be used in areas inaccessible to drilling rigs. Also important, boulder strewn soils do not impair accuracy of findings as sometimes occurs with probing devices. Where rippability is a factor, a table of velocities for rippable rock has been prepared by the Caterpillar Tractor Co. for use with the MD-1.

The reliability and dependability of the MD-1 is user proved over a number of years on thousands of jobs by operators all over the world.

See how you can profit on your next job with this simple to operate tool of the new age in earthmoving. Ask for a demonstration—operate it yourself after a few minutes instruction.

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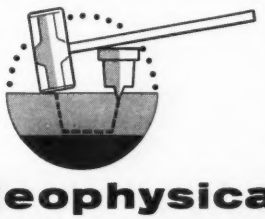
Michigan State Highway Dept.
Ontario Dept. of Highways
Alcoa (Aluminum Co. of America)
U. S. Bureau of Public Roads
U. S. Corps of Engineers
DuPont



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9 Twin Bridges

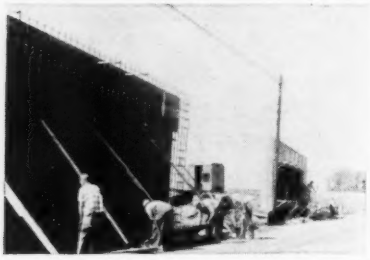
Symons Steel-Ply Forms Lick Tight Schedule

. . . Forms Set Horizontally and Stripped in Sections

Eight months to build the piers and substructure for nine twin highway bridges. Moore Brothers Construction Co., Verona, Virginia had this tight schedule to meet . . . and made it. Figuring concrete formwork correctly was an important factor in meeting the schedule.

The bridges are part of the 28-mile superhighway that connects the new Dulles International Airport at Chantilly, Va., with Washington, D.C.

On this project, the forms were assembled, stripped and moved easily by



Symons Forms are easily moved from completed pier (right) to new pier at left. Symons scaffold brackets aided materially in setting up forms.

manpower so that the forms could be reassembled on a second pier while the first was being stripped. Concrete was poured at the rate of about 3 feet an hour with each pier poured in a continuous operation.

The complete *Chantilly story* sent *free* on request. Symons Steel-Ply Forms are rented with purchase option.

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MORE **SAVINGS** FROM **SYMONS**

News of Members

(Continued from page 24)

Clinton B. F. Brill, from 1957 until early 1960 chairman of the New York State Thruway Authority, has assumed the presidency of the Brill Engineering Corporation, following the merger of his interests with the Franklin Engineering Corporation, formerly a subsidiary of Burns and Roe, Inc. In the past Mr. Brill has participated in the design and construction supervision of the remodeling of New York's Metropolitan Museum of Art; N. Y. International Airport; the 1939 World's Fair; and express highways in several states.

Charles G. Grosvenor, Jr., has been appointed district engineer for the Asphalt Institute at Santa Fe, N. Mex. Until recently he was vice president and manager of Falcon Air Maps, Inc., Denver, Colo. In his new position Mr. Grosvenor will provide engineering service for New Mexico and west Texas.

Joseph A. Bacci, Lieutenant Colonel, U.S. Corps of Engineers, was honored recently with the Army Commendation Medal for his outstanding job of supervising construction of the gigantic Clear (Alaska) Ballistic Missile Early Warning Station in his capacity as resident engineer. The area, one of three BMEWS Stations, is part of the nation's defense alert facilities against sneak polar attacks.

Clifford D. Williams, currently chief engineer of Patchen & Zimmerman and a member of Patchen, Mingledorf & Williams, both of Augusta, Ga., has received a distinguished service citation from his alma mater, Fenn College. Formerly head of civil engineering at Fenn, Mr. Williams has also served in the same capacity at the University of Florida. Recently two highway bridges in Georgia designed under his supervision received awards by the American Institute of Steel Construction in their annual competition for "esthetic steel bridges."

Ambrose G. Hampton, executive vice president of the State-Record Company, Atlanta, Ga., has been elected a director of the Commercial Bank and Trust Company. Mr. Hampton has served with the South Carolina Highway Department and with the U.S. Bureau of Public Roads in Raleigh as highway engineer from 1936 to 1955.

David D. Hill has been appointed by the Douglas Fir Plywood Association to serve as field representative in the Birmingham, Ala., regional office. His last job was as associate structural engineer with Patchen, Mingledorff & Williamson. Other additions to the Association staff include **Fearn LaBan,** for five years with the Mobile, Ala., consulting firm of Joseph H. Helmsing, who is New Orleans representative, and **Mujib S. Metti,** a former general construction management engineer with the Corps of Engineers in Detroit, Mich., who will represent the firm in the Albany, N. Y., area.

Nathan Cherniack, one of the foremost transportation economists in the United States, is winner of the Port of New York Authority's Howard S. Cullman Distinguished Service Medal "for his skill, energy and imagination as an economist to the Port Authority and the Port District for the past 37 years." Mr. Cherniack is now engaged in studies of movements of passengers, vehicles and freight through the Port of New York. Since 1936 he has been a lecturer at the Yale University Bureau of Highway Traffic. The Howard S. Cullman Medal has been awarded only once before.

Raymond F. Mottet, who first joined the Standard Oil Company of Indiana in 1952, has been named senior staff engineer in the company's general engineering department at Whiting. Mr. Mottet is a 1950 civil engineering graduate of the University of Illinois.

Rufus H. Carter, Jr., has been promoted from assistant chief to the position of chief of the engineering division of the U.S. Army Engineer District, Gulf, Teheran, Iran. Prior to joining the Corps of Engineers twelve years ago, Mr. Carter was executive secretary of the Rio Grande Flood Control Association.

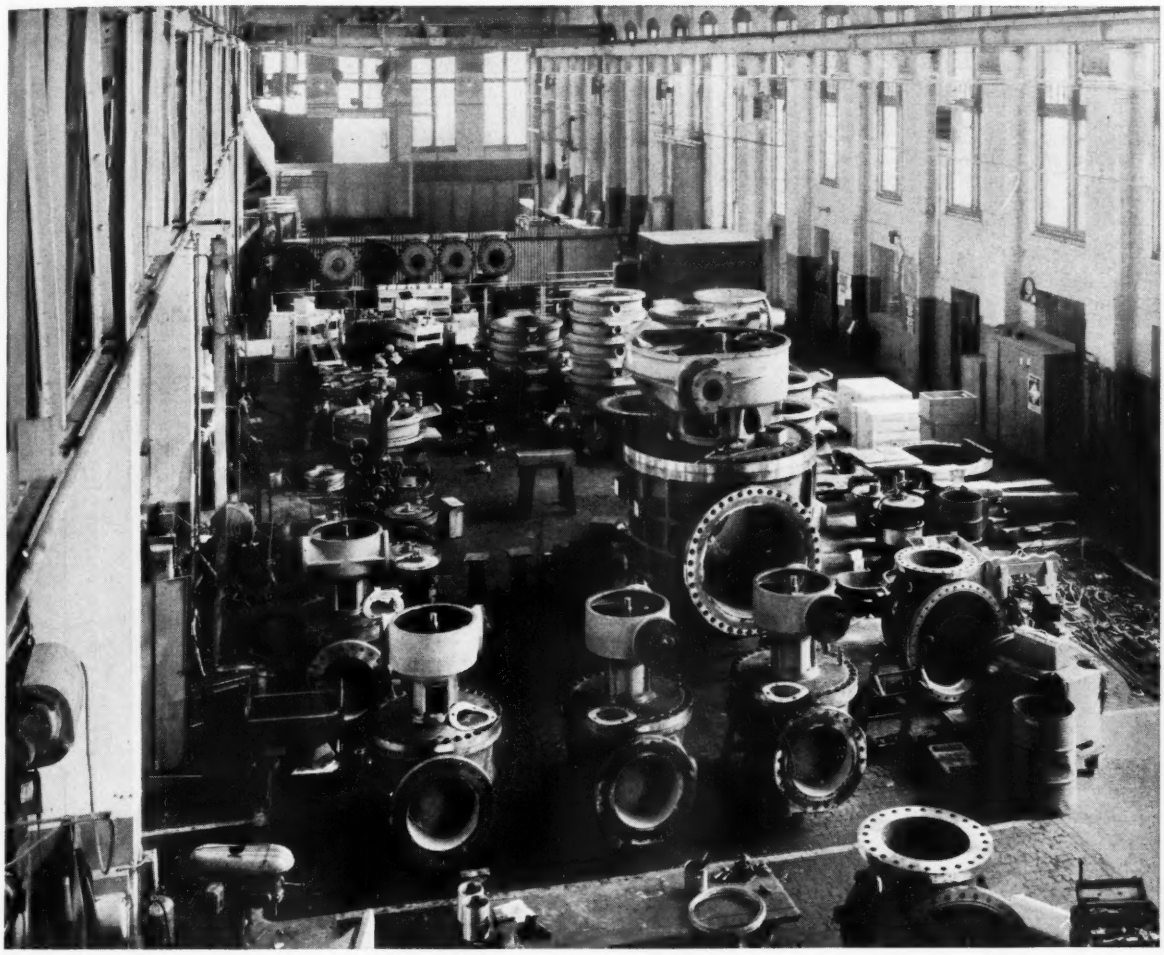
William Ward, of Houston, Tex., was recently chosen by the Prestressed Concrete Manufacturers Association of Texas to receive the Association's first award for outstanding design and use of prestress concrete in bridge construction. Mr. Ward is engineer assistant with the Texas State Highway Department.

Franklyn C. Rogers, with the Harza Engineering Company of Chicago since 1950 and for the past few years an associate of the firm, has now been promoted to chief civil engineer. Prior to 1950, Mr. Rogers taught and directed research in soil mechanics and highways at Rutgers University. Named associates of the company are **Robert B. Jackson,** who has been with it since 1956 and is now resident construction engineer on the Wanapum and Priest Rapids Developments in the State of Washington; **Earl J. Beck,** with the company since 1947 and now head of a civil engineering department; and **Victor A. Koelzer,** a member since 1956 and present head of the planning department.

Rennold G. Hanson has accepted the position of chief highway engineer with A. J. Macchi, engineers of Hartford, Conn., and Torino, Italy. In recent years, Mr. Hanson has supervised the design of numerous highway projects in the northeastern United States, as well as in the Middle East and the Caribbean area.

(Continued on page 88)

ALLIS-CHALMERS



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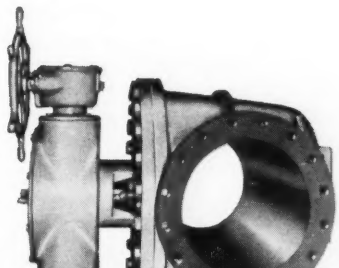

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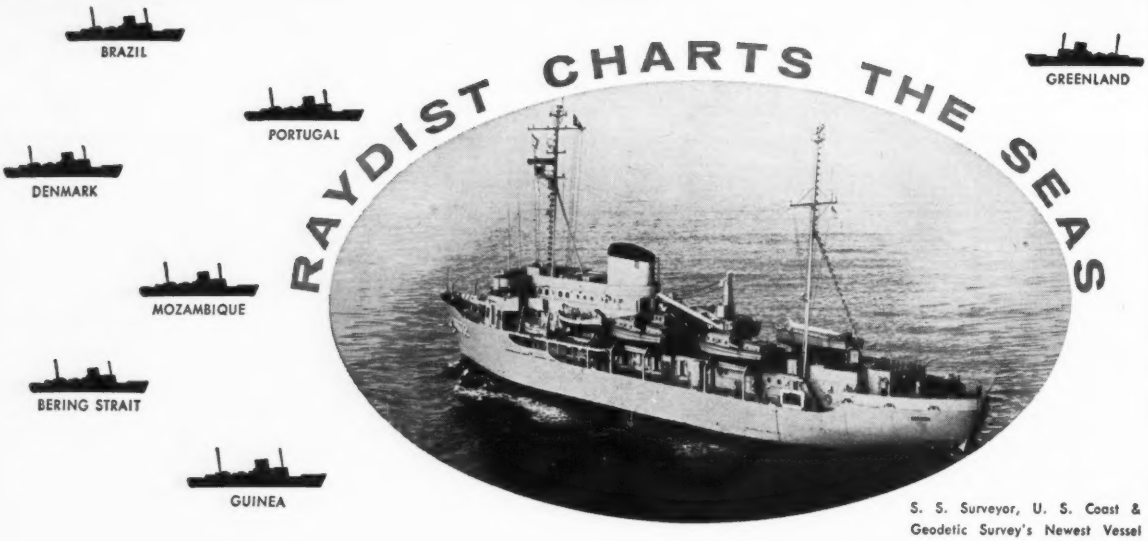

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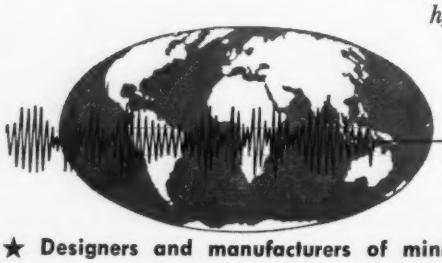

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. . . . . *Am-Soc Briefs*

▶▶ On the UEC fund front. . . . Several Sections — among them Mexico, Panama, and Oregon — continue active in the fund drive for the United Engineering Center. Of the thirty Sections still to fill their quotas, sixteen have passed the 70 percent mark and another eleven have less than half to go. Zone II is within a few hundred dollars of joining Zones I and IV, which are over the top. . . . ASCE stands at the 103 percent mark, with $821,678 to its credit. . . . The overall member gifts drive is 88 percent complete, with $461,000 to go. Figures are as of November 30.

▶▶ Public relations programs do pay off. . . . One case in point is a tribute to the profession that appeared in the Worcester Telegram this fall and is reprinted on page 47. From this generous and unsolicited tribute, apparently inspired by the ASCE Boston Convention, it might be inferred that the profession is getting its message across to thinking people.

▶▶ Yeoman service to the profession is being performed by ECPD Guidance Committees for recruiting students. ASCE members wishing to participate in this valuable program for assuring the nation enough engineers will find the details on page 73.

▶▶ Still on the subject of students. . . . Membership in the Society's Student Chapters is growing by leaps and bounds — from 2,600 at the end of the war to 11,200 in 1960. The biggest spurt — from 5,300 to 10,000 — took place between 1948 and 1949. In the years 1952 to 1955 there was a decline in membership, reflecting the drop in civil engineering enrollments. Since 1956 annual Student Chapter enrollments have been 10,000 or over.

▶▶ Attention, younger members. . . . . Members and students planning to enter essays on professional subjects in the 1961 Daniel Mead Competition for Associate Members and Students are reminded of a change in the rules governing the award. . . . One new inducement — publication of the winning papers in the Journal of Professional Practice. . . . The new conditions are explained on page 72.

▶▶ To find what is where in ASCE Publications, a valuable Cumulative Index is now available. An order form for obtaining this index for Proceedings (1950 through 1959), Transactions (1935 through 1959), and Civil Engineering (1930 through 1959) appears between pages 32 and 33.

GRIFFIN **Solves Another Dewatering Problem!** To build 11 double piers for the Chicago-to-St. Paul Expressway Bridge over the fast-flowing Wisconsin River, contractor procedure called for constructing three earth cofferdams in the coarse sand, gravel and boulders of the river . . . Typical of construction speed was the progress made in only 10 weeks in the cofferdam shown above: • Construct cofferdam—2 weeks • Install Wellpoint system and dewater to grade—one week • Excavate, drive piles and pour concrete up to river level—7 weeks.

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do you know that

This issue concentrates on highways? The $11 billion spent for road building and upkeep in 1960 underscores the importance of highways in the national economy. This enormous sum—more than twice the amount spent on roads and streets in 1951—far outstrips the growth of motor vehicle travel in the same period. In the past decade motor vehicle travel has increased about 50 percent, while highway expenditures shot up 114 percent.

▪ ▪ ▪

The Federal Highway Program is four years old? Since the start of the program in July 1956 more than 9,000 miles of the Interstate Highway System have been opened to traffic at a cost of $3.6 billion. This is over one-fifth of the projected 41,000-mile total.

▪ ▪ ▪

1960 was a profitable year for the toll roads? Despite the business recession and rising costs of operation, the toll roads around the country turned in a profitable performance this past year. As cases in point, the New Jersey Turnpike is earning more than twice as much as is needed to meet fixed charges, while the Pennsylvania Turnpike (first of the toll expressways) has almost seven times as much revenue as is needed. A marked exception to the prevailing situation was the Mackinac Bridge Authority, which serves the sparsely settled Upper Michigan peninsula. Passenger-car toll for this facility is $3.25.

▪ ▪ ▪

The annual tax take in the U.S. is $100 billion? Taxes collected by all governments in the United States—Federal, state, and local—in their 1959 fiscal years totaled $100 billion. This tax yield compares with a 1958 total of $98.4 billion. Increases in state and local taxes more than offset a slight drop in Federal tax revenue. Figures are from the U.S. Bureau of the Census.

▪ ▪ ▪

The government forecast is for a good construction year? Not in the least daunted by the almost professional pessimism of industry economists, the Department of Commerce's Business and Defense Services Administration forecast a record year for construction in 1961. According to BDSA, outlays for new construction in 1961 will reach $57.3 billion, representing a 4 percent rise over 1960, and even topping the 1959 record of $56.2 billion. Surprisingly—in view of signs of business caution—BDSA expects greatest strength to come from the privately financed area, which is expected to top $40 billion for the first time in history, despite forecasts of an almost imperceptible rise in housing starts (up 50,000).

▪ ▪ ▪

A personal radiation monitor has been developed at Oak Ridge National Laboratory? The tiny new safety device —pocket size and weighing only 3½ oz—emits a warning tone and flashes a small neon lamp in the presence of a gamma radiation field. Prototype models of the Personal Radiation Monitor in use at Oak Ridge have proved particularly useful in detecting small unknown radioactive contaminations and in reducing radiation exposure of employees manipulating "hot" objects behind shielding.

▪ ▪ ▪

Reservoir evaporation losses constitute a serious problem? Average gross annual losses through evaporation from reservoir surfaces are said to be 7 ft of water depth, and as much as 10 ft under severe drought conditions. Estimates place the total volume lost from artificial reservoirs in the U.S. at over 20,000,000 acre-ft. In the eleven Western states alone, annual evaporation losses exceed 11,000,000 acre-ft.

▪ ▪ ▪

No sharp changes in our energy sources are expected by 1975? In an important new study of energy use in the United States sponsored by Resources for the Future, Inc., Authors Sam H. Schurr and Bruce Netschert expect that in 1975 oil will account for two-fifths of the total, coal and natural gas one-quarter each, and natural gas liquids and hydropower the remainder. Atomic fuels may replace between 2.5 and 3.75 percent of present conventional energy sources, but are expected to have little significance in the overall energy picture.

▪ ▪ ▪

The outlook for engineers is good? The need for more sanitary engineers was stressed at the first National Conference on Water Pollution, held in Washington this December (story on page 46). And salaries for engineering teachers have increased by 14.7 percent in the past two years. Today's average basic salary for engineering teachers in U.S. colleges is $8,534, and this is supplemented by average income of $2,479 from outside professional sources. These findings are the result of a survey just completed by the Engineering Manpower Commission of Engineers Joint Council.

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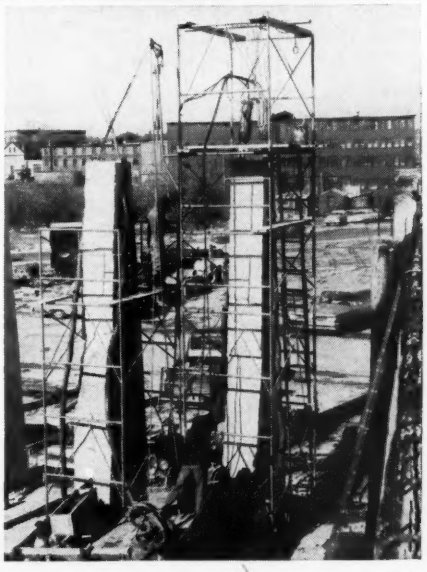
CIVIL ENGINEERING

NEW CONCEPTS IN HIGHWAYS

Prestressed granite masonry for a retaining wall

JOSEPH B. TAYLOR, M. ASCE
Research and Design Engineer
H. E. Fletcher Company, West Chelmsford, Mass.

Two-piece granite counterforts are seen in position on concrete footing before post-tensioning.



In post-tensioning operation, two double-acting hydraulic rams are in position to stress granite counterfort 21 ft high in tying it to the reinforced concrete footing.

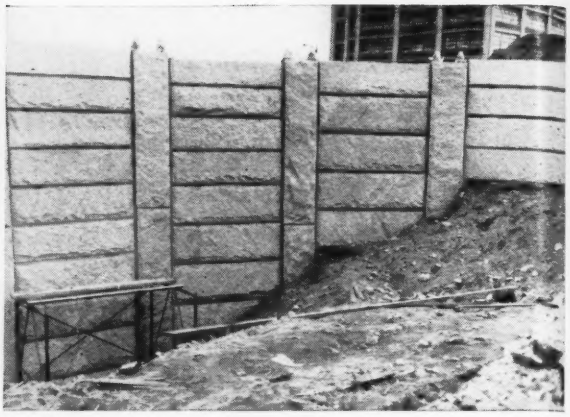
Counterforts, as high as 24 ft, of Chelmsford Gray granite, were post-tensioned to reinforced concrete footings to hold the fill for a grade separation at Lowell, Mass. Granite ashlar beams span 10 ft between the counterforts to retain a gravel fill. Conventional concrete backup is not required. Wing walls for two overpasses and retaining walls supporting the connecting roadways in this project all make use of this recent development in the construction industry.

This successful application of prestressing to the age-old art of granite masonry construction is on an interchange of the elevated, rotary type, which is being constructed under the supervision of the Department of Public Works of Massachusetts and the U. S. Bureau of Public Roads. A conventional reinforced concrete footing is used to support the wall and as the anchorage for one end of the post-tensioned element.

The Freyssinet system of prestressing is employed, using both the 12-wire units of 0.196-in. diameter and 18-wire units of 0.196-in. diameter. The embedded end was looped to form a "pigtail" with the bond between the concrete and the steel providing the anchorage. At the same time, flexible metal hose of 3½-in. inside diameter around the tendon was embedded 3 in. into the footing to permit grouting of the entire assembly after tensioning.

Granite counterforts with a face width of 2 ft, a height of up to 24 ft, and a depth in the wall of up to 5 ft, were next positioned on the footing. See Fig. 1. Counterforts over 12 ft in height were fabricated in two pieces.

Granite ashlar is set between counterforts for a wingwall on a 40-ft radius. Dowel holes in counterforts were field-drilled to match slots in ashlar.



Section of curved wingwall is complete except for coping. Upper end of the wires used for prestressing the granite counterforts will later be encased in the coping.

A thin bed of setting mortar was used at all joints to prevent non-uniform concentrations of stress.

Slots for the steel tendons were cut in the sides of the counterfort at the top. A steel anchorage plate provided the necessary bearing area to distribute the prestressing force on the counterfort.

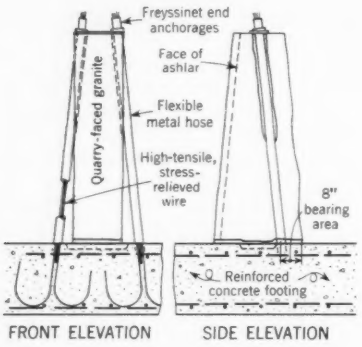


FIG. 1. Details of granite counterfort show prestressing method. Some elements were 24 ft high, handled in two pieces and held together by prestressing.

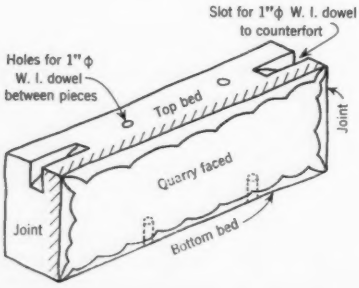


FIG. 2. Typical ashlar beam spanned 10 ft between counterforts.

When a sufficient time had elapsed to permit the concrete footing and the setting mortar to develop their full strength, the two steel tendons on each counterfort were post-tensioned simultaneously using matched hydraulic jacks activated by a single pump.

To protect the high-tensile, stress-relieved wire from corrosion, a grout mixture of equal parts of cement and granite crusher fines was pumped into the flexible metal hose from the low end and allowed to flow out the top. This insured complete removal of air and water from the jacket and thus total encasement of the wire.

The granite ashlar beams span horizontally between the counterforts. Chelmsford granite of structural grade has a modulus of rupture of approximately 2,000 psi. See Fig. 2. A conservative limit of 200 psi was used in the design. This resulted in an ashlar thickness that was a maximum of 14 in. at the bottom of the wall and a minimum of 6 in. at the top. These pieces of ashlar were secured to the counterforts by means of galvanized wrought-iron dowels 1 in. in diameter.

Holes in the counterforts for the dowels were field-drilled as each piece of ashlar was wedged into position. Vertical dowels between each piece of ashlar were also used to further tie the beams together. A reinforced concrete coping was used to cap the ashlar and counterforts and to carry the guard rail for the roadways above.

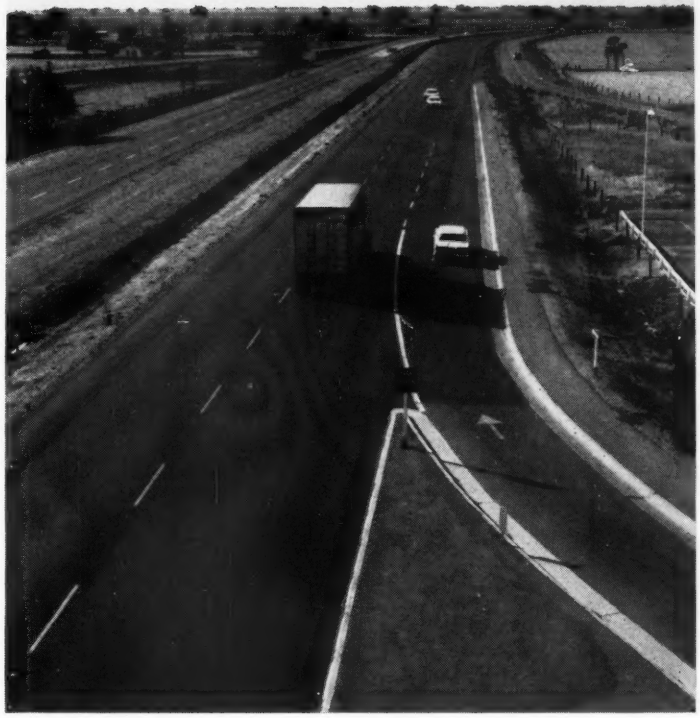
From 1954 to 1956, a research project sponsored by the Fletcher Granite Company was conducted by the writer at the Massachusetts Institute of Technology, under the direction of Prof. Myle J. Holley, Jr., M. ASCE. The applicability of granite to load-bearing structures, with particular relation to prestressing methods used in concrete structures, was the subject of this investigation. A determination of the specific properties of Chelmsford Gray granite was also undertaken.

The results of this study showed conclusively that by the careful application of post-tensioning techniques to granite masonry it is possible to utilize the inherent strength and durability of the granite and at the same time achieve an effective architectural treatment.

The excellent structural properties of granite are hard to duplicate. Its ultimate compressive strength of 30,000 psi is but one indication of its load bearing capacity. Its complete lack of compressive creep enhances its value in a prestressed structure.

Another major factor in the decision to try this new construction technique was the favorable "first-cost" picture. It has been shown that prestressed granite masonry is considerably less expensive than granite-faced concrete. Other types of structures are being studied for possible adaptation to this type of construction.

Green Engineering Affiliates, Inc., of Boston was the firm responsible for the design, under the supervision of John Rundlett, Simon Kirshon and James H. Kane, bridge engineers for the Massachusetts Department of Public Works. For the Department, Edward Cox was resident engineer in charge of construction. Coleman Bros. Corp. of Boston was the general contractor, with Christopher Vrachos, general superintendent. The H. E. Fletcher Co. of West Chelmsford, Mass., held the subcontract to furnish, set and stress the granite masonry, with the writer as project engineer.



Entrance terminal on California highway is typical of good design. Long merging area enters through route at a taper of about 50 to 1.

NEW CONCEPTS IN HIGHWAYS

Freeway operation—

Observations reveal good and poor highway design

JOSEPH BARNETT, F. ASCE, Deputy Assistant Commissioner for Engineering
Bureau of Public Roads, U. S. Department of Commerce, Washington, D.C.

A most important aspect of modern highway design is planned control of access. Practically every state has come to realize the great benefits from it and the necessity for constructing this type of arterial highway. All the highways in the present Interstate program and all toll roads have access control. Particularly convincing among its advantages are ease of travel, sharp reduction in accidents, and the long-range economy of highways that will not soon become obsolete.

Access control has a profound effect on design. In many ways it is easier to design a freeway than any other highway type. The speed is more uniform and predictable and the capacity per lane is more certain. On a freeway there are no uncertainties regarding future entrances or crossings, and profiles do not have to be fitted to existing entrances. Fewer traffic control devices are needed and signing is much simpler, although generally higher speeds demand larger signs and a greater reading distance.

The overriding condition that baffles highway engineers is dealing with human drivers of free-wheeling vehicles. With the great variety there is in the human mind and in human reactions it is never possible to tell precisely how a highway design element is going to work out. Much research is needed in this area.

In recognition of the need to evaluate the finished highway, the Executive Committee of the American Association of State Highway Officials appointed a Special Freeway Study and Analysis Committee "to study existing freeways under traffic, determine those features of design that cause operational difficulties, study accident histories, and report on those current design practices that should be discontinued and those that should be encouraged in the designs for the Interstate and similar programs." As of October 1, 1959, when the committee began its field trips, 6,130 miles of the Inter-

Signs and lights

- Pavement marking of lanes by a dashed line continuous for the full length of the road is helpful to drivers.
- Along the pavement edge marking should be a solid stripe, omitted at ramps.
- Overhead signs are most effective when lighted, whether or not the roadway is lighted.
- Reflectorized signs should be used when lighting is not used.
- Overhead signs are preferable to roadside signs.
- Continuous lighting is desirable but it is not certain that improved operation or a reduction in accidents justifies this.
- Even as little as one luminaire at each entrance and exit will be helpful.

state System, of which 2,259 miles were toll roads, were open to traffic as were many miles of freeways not in that system.

There was an advance collection of case histories of problem sites which included detailed plans, traffic and accident data, and solutions and corrections that had been found effective. The committee had the rare opportunity of examining these data and observing operation both night and day during periods of high and low volumes and under different weather conditions. Furthermore they had off-the-record conversations with design engineers, traffic engineers, local planners and enforcement officials, in fact, all persons concerned with the planning, design and operation of freeways.

Some of the observations are worthy of particular note. By and large the major features of design, alinement and profile, full control of access, 12-ft width of traffic lanes, and high-type surfaces, used uniformly by the states, were found satisfactory. Smooth traffic flow at volumes over 2,000 vehicles per lane per hour, including a reasonable percentage of trucks, was observed on freeways in which all other features of design, such as the spacing and details of interchanges, were satisfactory. Observed also were freeways in which all these major elements of design had been incorporated, yet where the peak-hour volumes could not be safely carried, principally because of the arrangement of interchanges and the inadequacy of their design, especially entrance ramps.

Reappraisal of capacity needed

Our present design concepts of capacity volumes on freeways need reappraisal. Under present practice the number of lanes is determined by taking the expected 30th highest hourly volume of the design year, adjusting it upward to an equivalent passenger-vehicle volume to allow for the expected percentage of heavy trucks, and dividing by 1,500 vehicles per lane in urban areas, 1,200 in suburban areas, and 1,000 in rural areas. The writer takes no issue with the use of volumes so much less than the operating volumes observed (since the 30th highest hourly volume can be exceeded by perhaps 30 percent at times), but the use of a capacity volume so much lower for rural areas than for urban areas needs investigation.

Use of lower capacity volumes in rural areas is based on the thought that greater speed is economically justified particularly since the construction cost per lane mile is generally lower. It appears, however, that greater speed is attainable in rural areas than in urban areas for similar design volumes since interchanges are farther apart, smooth flow is more certain, and the design volume is less likely to be exceeded frequently. Where there is an abnormal overload there is a natural adjustment which brings lower speeds and higher capacities. This could act as a safety factor even if capacity volumes somewhat greater than those now used are employed in determining the number of lanes.

With regard to the cross section, it was in shoulders and medians that there were some variations. The committee felt rather strongly that shoulders should be paved with a usable width of 10 ft on the right and a nominal width on the left. There should be no curb, even a low one, between the through-traffic lane and the surfaced shoulder since it would act as a deterrent to emergency use of these areas. Turf shoulders were looked on with disfavor since they discourage drivers from using them, particularly truck drivers. It was observed that paved flush shoulders, with vegetation beyond the shoulder, are just as pleasing in appearance. Where inlets are needed for drainage they should be located at or beyond the outer edge of the shoulder. This not only reduces surface flow on through-traffic lanes but also reduces cost in that fewer inlets are required since temporary ponding on the shoulder is not objectionable as on through-traffic lanes.

There was little doubt that the wider the median the safer the highway, and there was added benefit in reduction of headlight glare. The committee also noted improved appearance, reduction in monotony, and lower cost when the median varied in width and each roadway was separately designed in alinement and profile to fit the terrain. Where a narrow median is the only feasible one, a barrier in it reduces the rate of serious head-on collisions, possibly at the expense of an increase in the less serious rear-end collisions. The committee felt that where widths in excess of Interstate standard minimums are not economically justified, consideration should be given to a barrier in medians of highways carrying, say, 40,000 or more vehicles per day.

Excessive use of guardrail

The committee noted in some areas excessive use of guardrail. In fact, guardrail was often used where it would have been less costly to flatten the side slopes. Improved safety and appearance—and in most cases a reduction in cost—result from wide, flat slopes of 4 to 1 or flatter and the elimination of guardrail.

The committee took special note of lateral clearances, particularly at structures both under and over the roadway. Where minimum lateral clearances called for in the Interstate standards were used, there is little or no effect on lateral placement of vehicles and therefore no effect on capacity. While comprehensive controlled observations are lacking, there was a general feeling that lateral clearances well in excess of the minimum standards were desirable for safety and should be used where economically feasible. On freeways expected to have volumes approaching capacity, lateral clearances at least as great as a full shoulder width were considered desirable also for maintaining capacity, since a vehicle stopping on a through-traffic lane under such circumstances can seriously impede traffic flow.

The committee also observed that some obstructions such as light standards and sign supports were not located with sufficient lateral clearance. They should have as much clearance as that to parapets, piers and walls. They should not project inside the faces of guardrails and walls, where they might snag a vehicle leaving the pavement.

Entrance and exit ramps

Smooth flow, capacity, and safety of freeways were found to be affected by the spacing and design of interchanges. Where ramps were spaced liberally and designed so that traffic could leave and enter through-traffic lanes at the operating speed of the freeway, little difficulty was observed and the full capacity of the through-traffic lanes was maintained.

Exit-ramp terminals should be designed to give the driver a clear cue that this is a point of departure from the through-traffic lanes. Furthermore he should be able to accomplish the exit without much deceleration on a through lane. Deceleration should take place on the turning roadway or on a parallel deceleration lane. The high-speed exit is best provided by a flat angle of 4 or 5 deg. The exit terminal should be visible far enough ahead of the point of departure to enable drivers to read signs, shift lanes and make the exit maneuver.

The neutral wedge approaching the nose should be pavement marked. Where such an exit was provided there was no evidence of the type of accident in which vehicles run into the

approach nose—so prevalent on freeways in which these designs are inadequate.

Here also curbs of any kind between areas for moving vehicles should be avoided. The approach nose should be offset from the through-traffic lane by the width of the right shoulder. No curb or other deterrent should be placed beyond the nose so that a driver who has inadvertently left the through lane and is unable to return because of high volume in the outer lane can proceed onto the shoulder. See Fig. 1.

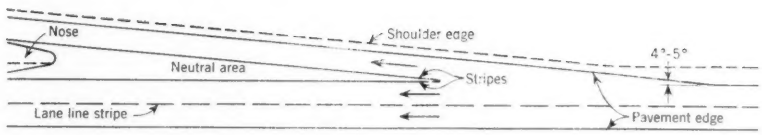


FIG. 1. High-speed exit is best provided by a ramp at a very flat angle—4 or 5 deg.

By far the most important item of design affecting capacity and accidents on freeways is the entrance ramp and its terminal at the through-traffic lanes. The distance between ramps must be liberal and drivers on the ramp and on the through-traffic lanes must be able to see each other for an appreciable period of time so as to effect an orderly merger at operating speed. For this reason the ramp approaching the terminal and the through-traffic roadway should be nearly parallel and at the same level. Poor visibility causes entering drivers to hesitate, or even stop. From this position it is extremely difficult to utilize the available short gaps to enter the through traffic, a condition necessary for high capacity.

Where there is poor visibility, accidents, particularly of the rear-end type, occur frequently between entering and through-traffic vehicles and between entering vehicles and those behind them on the ramp as a result of the erratic and uncertain behavior of the forward entering driver.

Entrance ramps, regardless of the width on the ramp itself, should be one lane wide where they approach the merging nose. See Fig. 2. For freeways with high volumes, the entrance should have a long merging area with a taper at an angle of about 50 to 1. The merging nose should also be offset from the through-traffic lanes about the width of the shoulder. To insure that vehicles will enter at the extremely flat angle desired, a short curb on the outer shoulder edge, or even a heavy pavement marking line, should be provided for a short distance beyond the nose.

With a ramp designed so that vehicles can approach the merger at a good speed, with good visibility and the flat angle mentioned, no warnings are necessary. Stop signs and triangular yield signs should be avoided, and even "merging traffic" signs are deemed unnecessary. The area of merging should be flush, without any pavement marking.

The arrangement of ramps, particularly their location with respect to one another, should be determined in initial planning and design to insure free flow on the through-traffic roadways. There should be consistency in the design of entrance and exit ramp terminals in regard to location, type of design, and dimensions.

Preferably all ramps should be on the right of through traffic because the public is accustomed to this location, but special situations may make it necessary to have a ramp terminal on the left. A left exit terminal operates smoothly. A left entrance terminal, on the other hand, poses problems because the driver is on the left of the vehicle and a longer merging area than one on the right is necessary.

As a basic plan in urban areas there should be more exit capacity from a freeway than entrance capacity. This is to insure freedom of movement on the through-traffic roadways by providing liberally for exit peak volumes, whereas back-up on an entrance ramp will not necessarily disrupt freeway through traffic. The spacing between ramps should be sufficient so that the tapers for successive ramp terminals do not overlap. Where they overlap, or even where their ends are close to one another, an added lane should be provided between the entrance and exit ramps. The spacing between ramps also should be sufficient to enable adequate signing of the freeway. Such signing should be considered and anticipated in the initial planning and design.

Interchanges

In rural areas the problem of the operation of cross streets is not serious, particularly where the cross-road is not likely to be used to capacity. The inexpensive diamond type of interchange is appropriate in most rural areas. It is easy to operate because it gives drivers no sense of confusion. Furthermore it is easy to sign and basically simpler than any other interchange type. There are cases, however, where the cloverleaf type is appropriate despite its many undesirable features.

In urban areas the high cost of right-of-way and construction for the cloverleaf and the intermittent type of operation on nearly all cross streets make the diamond type of interchange, with and without combinations of one-way frontage roads, a much superior design. On this type, smooth operation with extremely high turning volumes was observed. With coordinated traffic control and proper design in relation to storage of vehicles awaiting the green light, more traffic can be handled through a diamond-type interchange than a cloverleaf. Of particular importance, however, is the insurance that the traffic on the cross street will fit in with the circulation of the city streets. We are confronted here with the necessity for insuring free flow on the freeway, which conflicts with the desire of city officials to distribute the traffic to as many streets as possible.

Insurance of free flow on the freeway requires, as previously stated, the design and spacing of entrance and exit ramps which force the spacing of interchanges at well over a mile. Some city officials want a ramp to nearly every street. The answer is cooperation throughout the planning and preliminary design stages between the designers and the city officials, public works officers, traffic engineers and police to insure that the ramps are lo-

FIG. 2. Entrance-ramp terminal for high-volume freeways is designed so that vehicles can approach the merger at good speeds, with good visibility at the recommended flat angle. The actual area of merging should be flush, without any pavement marking.

cated where the future volumes using them can be quickly fitted into the ultimate street pattern. Of particular benefit in this regard is the use of one-way streets on crossings of the freeway and the splitting of the ramps among two or more streets.

One-way operation of frontage roads was clearly found superior to two-way operation. Continuity in the frontage road provides an additional safety valve for unusual freeway peak loads. One item of design that should be considered is the location of the slip ramp between the through-traffic roadway and the frontage road. The section of the frontage road between this ramp and the important cross street becomes, in effect, part of the ramp and it should be protected as much as feasible from roadside interference of private businesses and from confusing connections with other public streets. The design of the frontage road for this section should be ample for the expected storage of turning vehicles approaching the crossroad.

Accident reporting

There is a great need for more complete accident and operating data. Accident reporting at present is done by officials whose prime purpose is law enforcement. They do very well in reporting accident causation considering the handicaps under which they work. Even the location of an accident on a freeway is difficult to determine quickly, and law enforcement officers should be assisted in this by every means highway engineers can devise. The freeway should be marked in such a way that the location can be quickly established.

What is needed most however is accident and operating reporting with special emphasis on the cause of the trouble with reference both to the drivers and to the physical condition of the highway. Only thus can the ever-changing factors in design get proper recognition.

Because highway design is in a continuous state of flux, it does not seem wise to prepare final plans too many years in advance, except for reservation of right-of-way, which can be done on the basis of preliminary plans. Knowledge will increase if all highway personnel, from the planners right through to the maintenance and operating officials, are made aware of the need for proper observation, reporting and analysis.

(This article is based on a paper presented by Mr. Barnett before a Highway Division session at the ASCE Convention in Boston, Mass.)

Worker carries a sheet of welded wire fabric 13 ft long and 7½ ft wide, to be laid adjacent to curb-side strip already in place. Wire fabric is expected to reduce reflection cracking of new surface over cracks and joints in existing portland cement concrete pavement.

NEW CONCEPTS IN HIGHWAYS

A FIELD TEST OF REINFORCED ASPHALT

Resurfacing job utilizes welded wire fabric in controlled research project

Paver has been driven over sled. After worker fastens the tow chains, the paver will be moved up about one foot, bringing sled into proper position to iron out the fabric as paving proceeds.

One of the first "completely controlled" experimental field resurfacing jobs with reinforced asphaltic concrete was carried out last summer to improve a 1½-mile stretch of U. S. Route 44 just east of Poughkeepsie, N. Y. Although the existing pavement of portland cement concrete was generally in passable condition, several of its 40-ft-long slabs had one or more fairly severe transverse or corner cracks. This condition as well as the need to increase the width of the old pavement influenced District Engineer Kurt G. Rauer and his staff to make a test installation of asphaltic concrete resurfacing reinforced with wire fabric. The old pavement, 18 to 20 ft wide, was to be widened to the present 24-ft standard width.

PROBLEM:
How to widen an existing pavement of portland cement concrete, generally in good condition but with fairly severe transverse or corner cracks in some of its 40-ft-long slabs.

SOLUTION:
Resurfacing with reinforced asphaltic concrete, on U.S. Route 44 just east of Poughkeepsie, N. Y.

It was felt that the placing of welded wire fabric in the asphalt mix over the joints between the old pavement and the widening sections, and over the transverse joints and cracks in the old pavement, would be an effective way to test the effectiveness of the fabric in reducing "reflection" cracking in the new surfacing, long a problem in this type of construction. The program for control and comparative testing established by the engineers consisted of the deliberate omission of the steel fabric from certain complete sections in the 1½-mile length of pavement and from the patches over some of the transverse cracks.

To assure accurate test results in future years, a careful slab-by-slab crack survey was made and plotted, and the actual location of all breaks in the pavement was recorded to the inch by reference to station markers along the right-of-way. This record also shows exactly where the steel fabric was placed and where it was omitted.

As a further aid in checking test results in future years, the Bureau of Physical Research of the New York Department of Public Works made one of the first major applications anywhere of a new continuous-strip photographic process. By this means every inch of the 1½-mile stretch was recorded pictorially before the work started. It is anticipated that a similar photographic record will be taken after the lapse of several years. A side-by-side comparison of the two film records will then be made in order to observe the effectiveness of the steel fabric in reducing cracks.

A construction problem

The principal problem the contractor had to solve was proper adjustment of the rails and sled which ride outside of, and between, the paver's crawler tracks to "iron out" the steel fabric, keep it down in the asphalt mix, and prevent it from becoming entangled in the paver's distribution screw. After a short test run of a few slab lengths the day before major construction started, it was decided to extend the trailing ends of the sled and rails completely under the conveyor screw so as to eliminate catching of the wire fabric.

This alteration was done overnight, and the next day—the first day of full-scale work—the paver rode over the steel mesh and placed a normal tonnage of hot mix. That the contractor was able to pave a course of asphaltic concrete 1½ in. thick over wire fabric with only minor delays is attributed to careful workmanship and close supervision. Experience with previous fabric-in-asphalt jobs indicates that 1¾ in. is the minimum compacted thickness in which fabric has been readily placed in the past.

The strips added to widen the pavement consist of a layer of gravel 1 ft thick topped by 6 in. of plant-mix asphalt (45 SY). Stabilized shoulders extending from the edge of the new pavement to the new ditch line were then built up.

Resurfacing was carried out in the following sequence: (1) an evener course of asphaltic concrete averaging 1½ in. thick was placed in selected locations; (2) the binder course of type 1A asphaltic concrete was placed (including the 3-in. by 6-in.-mesh, welded wire of 10 gage in both directions), with stone having a maximum size of ¾ in.; and finally (3) a top or wearing course 1 in. thick was placed, of type 1A asphalt with stone of ½-in. maximum size. Compaction was done by two Buffalo-Springfield rollers of 10-ton and 12-ton capacity. The entire 1½-mile stretch of highway was resurfaced in this way except that the reinforcing was omitted in selected areas for test purposes.

All the sheets of fabric for reinforcement of the resurfacing were delivered to the site in 13-ft lengths and in widths of 5, 7½ and 8 ft. The sheets 5 ft wide were used over the longitudinal joints and those 8 ft wide over cracks and transverse joints. For reinforcing the full width of the 24-ft-wide highway, two sheets 8 ft wide and one 7½ ft wide were butted lengthwise, allowing 3 in. of clearance on each side.

In every case the reinforcing was placed in single layers or sheets. There was no doubling of sheets. Experience has indicated that one sheet of fabric will act to control and minimize any tendency for the asphaltic concrete to crack over cracks in the old pavement.

The blanket reinforcing was used over areas where the transverse cracks (and some diagonal ones) were most numerous. The reinforcing was placed in strips in areas where there were few or no cracks. The strips were placed over the transverse joints and over the longitudinal joints formed where the widening strips adjoin the old pavement.

The test, by omission, was effected by deliberately omitting fabric over some of the transverse cracks that were scattered over several slabs. Another test control section consisted of five consecutive slabs in which only a single transverse crack occurred over half a lane width. On this 200-ft section, all reinforcing was omitted, thus offering a good comparison with the sections where strip reinforcing was placed over the joints.

Such fabric sheets have usually been placed so that the wires parallel to the axis of the pavement will be on the up side, for easier passage of the paver over them. However, on this job no trouble was experienced when, in order to make the sheets lie flat, they were sometimes placed with the transverse wires on the up side.

Where necessary, for example when the paver was about to move up onto the first sheet of wire fabric in a reinforced section, the edge of the sheet nearest the paver was secured with concrete nails to the underlying evener course of asphaltic concrete.

The $148,312 contract was carried out by the Callanan Road Improvement Company of South Bethlehem, N. Y. The project engineer for the State of New York was David P. McCoy, and the assistant district engineer, M. N. Sinacori, M. ASCE.

Arterial routes for satellite communities

ARCHIE N. CARTER, F. ASCE, President, Carter, Krueger & Associates, Inc., Minneapolis, Minn.

Advance planning of the road network will yield big savings in the cost of future arterial routes through rapidly growing communities. Satellite communities around large metropolitan centers are frequently in need of such planning. Advance planning of streets connecting to arterial routes will permit both the arterial and the collector streets to function more effectively.

In the Midwest growth trends indicate that much of the future increase in population will occur adjacent to the large cities. The populations of most small communities in agricultural areas may decrease, as may the number of farm families. In Minnesota, for example, the rural population decreased between 1950 and 1960, and some 40 counties in the state lost population. In contrast, during the past decade the population of the five-county metropolitan area centering around the Twin Cities of Minneapolis and St. Paul jumped from 1,151,000 to nearly 1,500,000. It is forecast that, during the next decade, half of the future growth of the entire state of Minnesota will take place in the Twin Cities region. By 1980 the population of this entire metropolitan area is expected to exceed 2,000,000.

Rapid growth of satellite communities

Much of this increase will be in the suburbs or satellite communities. This growth trend can be illustrated by the forecasts for Hennepin County, where about half of the population of the metropolitan area now lives and where about the same proportion of its population is expected to be living in 1980. Hennepin County covers 609 sq miles, and the city of Minneapolis, on its eastern edge, covers almost 54 sq miles, or nearly 9 percent of the county's total area. See Fig. 1. In 1960 the population of Minneapolis was 481,000 and that of the remainder of the county, 355,000. By 1980 Minneapolis is expected to increase to only 550,000 while the rest of the county will jump to 647,000. Expressed in a different way, the population of Minneapolis will increase about 12 percent while that of the rest of the county will rise 82 percent.

Under the writer's supervision our firm is providing engineering assistance to several of the rapidly growing communities in Hennepin County with a combined area of about one-fourth of the county. This work has provided an excellent opportunity to evaluate the benefits of advance highway and street planning for satellite communities looking forward to large increases in their population, and in turn, in the volume of highway traffic.

Land-use study needed

In planning a future network of expressways and arterial streets for a given community, consideration must be given to present and future land use. The volume and character of the traffic to be generated by the expected land uses must also be evaluated. General layouts and design standards must be such as to assure the desired level of safety and efficiency.

In this discussion a few definitions will be useful:

Freeway, a highway on which access is largely or completely controlled.

Arterial street, a major thoroughfare used primarily for heavy traffic, and serving as an arterial trafficway between the various districts of the community.

Collector street, a street that carries traffic from minor streets to the major system of arterial streets and highways, including the principal entrance streets in residential areas.

Minor street, a local street used primarily for access to abutting properties.

In planning an adequate street network, including expressways, arterials and collectors, very close cooperation is required among the local community, the state highway department, the county government, and the governing bodies of adjacent and nearby communities. Through such cooperation, large savings in the cost of constructing major streets and highways will be made possible, transportation facilities that are more efficient will develop, and better community planning will follow.

By zoning, preparation of a comprehensive plan, development of a good platting code, and adoption of a good thoroughfare map, a community that has a small population at present but expects large growth in the future, can obtain more effective land use. Areas needed in a few years for important street and highway projects can be kept free of buildings and encroachments. Under the state laws of Minnesota, and probably those of other states, local governments now have the power to protect future rights-of-way. Right-of-way funds are saved by planning that avoids the necessity of removing or demolishing homes or other structures in the future.

The Village of Corcoran, in Hennepin County, about 10 miles from Minneapolis, is an example of what can be accomplished by forward-looking planning. Right-of-way is being protected for both existing and projected streets to a greater width than is at present available. This is being accomplished through setback requirements in the zoning and the platting codes recently enacted. The combined cost of preparing the zoning regulations, the platting code, and the thoroughfare map is only a small part of the possible future cost of demolishing a single important structure. The Village of Corcoran until recently was a township and the municipality now has a population of only 600. However a high rate of future growth is anticipated.

Protecting street capacity

Local communities can protect the capacity of an arterial street by restricting the number, spacing and location of the entrances to it. A good platting procedure provides for infrequent connections to an arterial street by requiring collectors that will serve a number of lots.

A part of the street layout of the new Medina Morningside Subdivision in the Village of Medina, is shown in Fig. 2. This plat, prepared by the consulting firm of Kelley and Kelley, Inc., illustrates how access to a county highway for a large number of lots was restricted to a single entrance. This arrangement, which prevents traffic from the lots immediately adjacent to the county arterial from backing directly onto it, should be very helpful in pro-

tecting the future capacity of the county road.

Precautions must also be taken to assure that the collector street joins the arterial route on a gradual grade so that traffic can stop easily under all weather conditions before entering the more important route. The intersection should also be planned to provide adequate sight distances.

In those Hennepin County communities where our firm has aided in the drafting of the zoning and platting codes, subdevelopers seeking access to a state highway are required to have their plans approved by the State Highway Department. Similarly, where a connection to a county road is desired, the developer must secure the approval of the county department. These requirements permit the department involved to make recommendations and to request improvements. This is particularly true where future improvement of the state or county route is being planned and major changes in layout or grades will be necessary. In such cases the connecting streets can be designed to be in keeping with the changes planned for the future.

Engineers assisting Hennepin County communities with a scattered population find that owners of land adjacent to state, county and other future arterial routes frequently desire to sell such land piece by piece or by metes and bounds descriptions. In following this procedure, owners of large tracts are often unaware of the need to protect the capacity of the arterial routes. Nor do the present owners always appreciate the traffic problems that might develop if the several new owners all followed the common procedure of laying out the driveways serving their homes so that they must back their vehicles onto the arterial to gain access to it.

Recently the owner of a farm property in the Village of Medina proposed to sell a one-acre tract to a Minneapolis resident who wanted a suburban home. The owner of the farm first proposed to use the layout shown in Fig. 3, right, to sell a home site adjacent to a small stream and identified as Lot No. 5. However, on request of the local authorities, the owner had other layouts prepared and the planning commission finally approved that shown in Fig. 3, left. It is to be noted that this layout controls access to the county road and permits orderly development of the remainder of the farm.

To summarize briefly, engineers who assist rapidly growing satellite communities in highway planning should find this work not only interesting but valuable to the local community being served. Procedures that may make this planning work more effective include:

1. Preparation by the local community of a comprehensive plan, zoning code, platting regulations, and thoroughfare map.

2. Realistic enforcement of the codes and regulations that are developed.

3. Maximum cooperation among state, county, and local officials in planning activities relating to highway transportation.

4. Continued evaluation of all codes, procedures, and plans to see how they can be improved, made more effective, and revised to meet changing conditions.

To conclude, no plan can avoid all future problems but a good plan will be a great help.

The writer wishes to acknowledge the assistance and cooperation received from the Minnesota Department of Highways, the Twin Cities Metropolitan Planning Commission, and the Highway Department of Hennepin County in the preparation of this article.

(This article was originally presented by Mr. Carter as a paper at the ASCE Boston Convention, before a session of the Highway Division.)

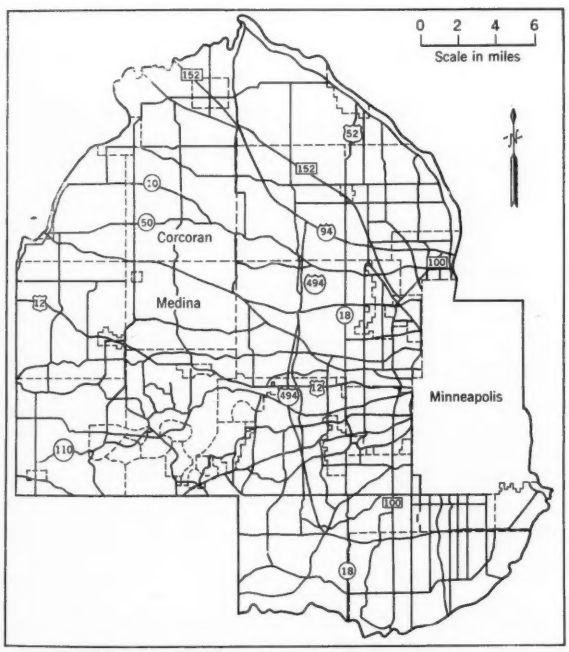


FIG. 1. The area around Minneapolis is expected to develop rapidly. Access to roads in what are now rural communities, such as Corcoran and Medina, is planned to preserve the capacity of arterial highways when traffic becomes heavier.

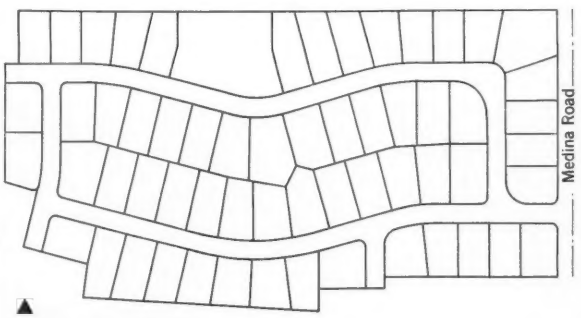
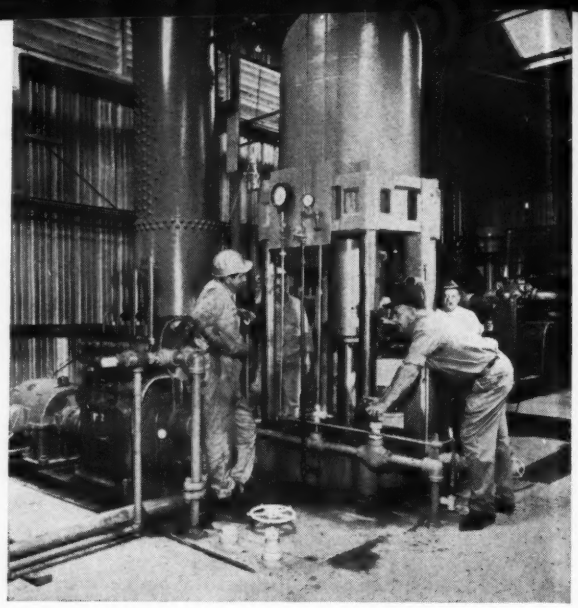


FIG. 2. To preserve the arterial capacity of a county highway, access for a new subdivision was restricted to a single entrance.

FIG. 3. The development plat at far right was rejected by local planning commission. Provision for a future street, near right, made it acceptable.

The shield was erected in a sheetpile-protected excavation. Here the first liner rings are being set at the East Boston ventilation building.



Water for operation of the hydraulic jacks is provided at 6,000 psi and 28 gpm by two Worthington pumps. Accumulator keeps constant pressure on the line.

NEW CONCEPTS IN HIGHWAYS

Constructing a soft-ground tunnel under Boston Harbor

CHARLES A. RICHARDSON

Vice President and Manager
Perini Corporation, Boston, Mass.

To connect Boston with East Boston the Lt. William F. Callahan, Jr., Tunnel is now being constructed under Boston Harbor by the Perini Corporation. This tunnel, designed by Singstad and Baillie of New York, N.Y., is being built for the Massachusetts Turnpike Authority under a $29,114,000 contract. Work was started in September of 1959. It is expected that the tunnel will be opened to traffic in November 1961.

The tunnel is being constructed by the shield method. The shield is of the conventional, open type, made of heavy steel plate and structural steel supporting members. This shield measures 19 ft 6 in. in length and has an outside diameter of 31 ft 4 in. It has an 8-ft 2-in. tailskin, of 30-ft 10-in. inside diameter, and a cast-steel cutting edge. There are three working levels. The shield is driven with 28 shoving jacks of 200-ton capacity each and is equipped with a hydraulically operated erector arm for setting lining segments. The hydraulic pump and accumulator for operation of the shoving jacks and erector arm are located in a nearby compressor house.

The conventional method previously used on shield-type tunnels calls for the erection of the shield in the shaft of the ventilation building. The shield is then driven through an oversized drum-ring girder and into a drum-ring girder installed in the ventilation shaft at its opposite end. This method would have delayed completion of the ventilation buildings until tunnel driving was finished.

Fast construction schedule

The Lt. William F. Callahan, Jr., Tunnel is to be completed in about 27 months.

In lieu of assembling the shield and starting the driving within the ventilation shaft, the shield was erected in a small cofferdam built adjacent to the East Boston ventilation shaft. At this point the top of the tunnel is about at ground level. The shield was assembled on a concrete cradle to insure that the proper line and grade would be established.

The earth ahead of the shield was excavated to about mid-height of the tunnel and breast-boards were installed up to this height. Then the space between the shield and the sheetpiles was backfilled and the sheetpiles withdrawn in preparation for the first shove. There was concern lest, when

the shield started to move, the reaction of the jacks would cause movement of the ventilation shaft. To reduce this danger thrust blocks were constructed from the shaft walls to the sheeting to prevent sliding and movement of the shaft.

Excavation ahead of the shield by clamshell bucket removed about one-half of the face so that very little pressure was required at first to thrust the shield forward. Reaction pressure against the shaft was thus kept to a minimum. As increased pressures were required, rings of lining were added so that skin friction with the existing ground was built up to take the reaction.

Adjacent to the Boston ventilation shaft a smaller cofferdam is being constructed to receive the shield for dismantling. This method will permit completion of both ventilation buildings in their entirety while work progresses on the tunnel operation.

The primary lining of this tunnel is of fabricated structural steel with an outside diameter of 30 ft 8 in. This lining is unique in that it was designed to serve as the structural lining of the tunnel, the concrete lining being secondary and used only to protect the structural steel and as a filler for the tunnel finish. Generally cast iron has been used for the primary lining of subaqueous tunnels. Where structural steel lining has been used, it has functioned only as a secondary lining, reinforced concrete being utilized to resist external pressures.

The fabricated lining being used on the Lt. William F. Callahan, Jr., Tunnel is made up of liner plates 32 in. wide. A total of 1,815 rings is required for the 4,840-ft distance between ventilation shafts. Each ring consists of 11 equal segments 105 in. in length, the eleventh segment being composed of two plates, of which one is the key plate—the last plate to be inserted in the ring. The segments of liner plates have a skin plate ⅝ in. thick, built up with bulb angles and stiffener plates. Each plate weighs about 1,500 lb.

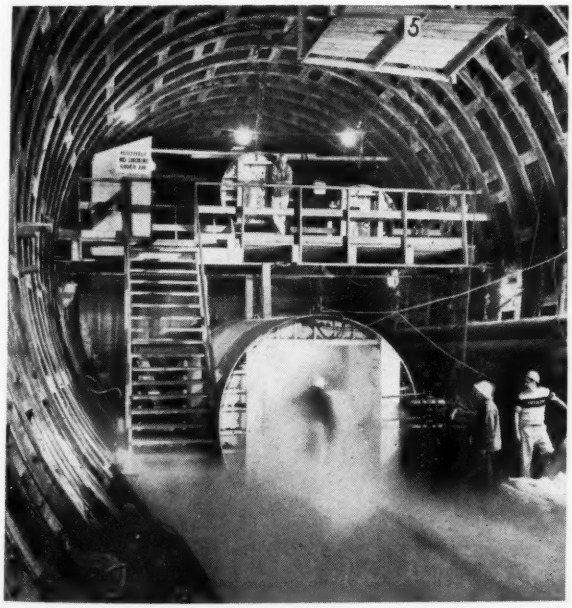
Plates are connected with high tensile bolts of 1-in. diameter; 354 bolts are required to complete the erection of one ring. Fabrication tolerances were $+\frac{1}{32}$ in. in width and $-\frac{1}{16}$ in. in length. On one side and one end of each plate there is a machined groove into which is fitted an ungraphited asbestos gasket ⅜ in. square.

A handling problem

With this type of steel lining numerous problems have been encountered. Because each skin plate must be protected from the corrosive action of salt water, a bitumastic enamel coating was specified, thus requiring extreme care in handling the plates so as not to damage the coating. Consequently, unlike the cast-iron segments, which normally are dragged from tunnel flat cars by a chain to the erector arm, the steel units must be transferred from the steel cars to the erector arm in such a manner as not to damage the enamel lining. The solution to this problem is the use of an Austin-Western hydraulically-operated boom, known in the tunneling field as a "cherry-picker." The cherry picker is mounted just behind the shield erector arm on a structural frame that slides along the wood-tie floor.

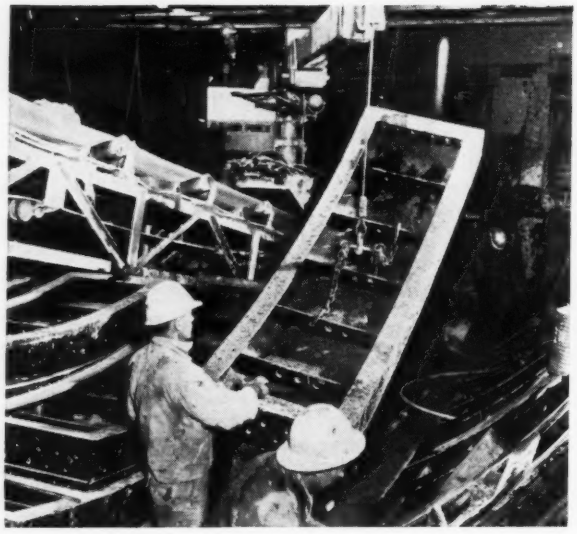
There is a continual problem in keeping the shield and lining in the same plane, while at the same time maintaining grades and skin clearances for the segments. In correcting alignment and grade and for use on curves, taper rings are used. Here again there was a problem, since taper rings are conventionally designed with 1½-in. and 2½-in. tapers. With such a design there was no control as to where the key plate would fall, and it could fall below the spring line, which is not desirable in the erection of segments. To overcome this problem all taper rings are designed for a 1½-in. taper but with two types—a riser taper and a depressor taper—so that no matter where the correcton is applied, the key plate is always above the spring line.

The steel liner rings have proved to be more flexible than the cast-iron rings and a horizontal squeeze has oc-

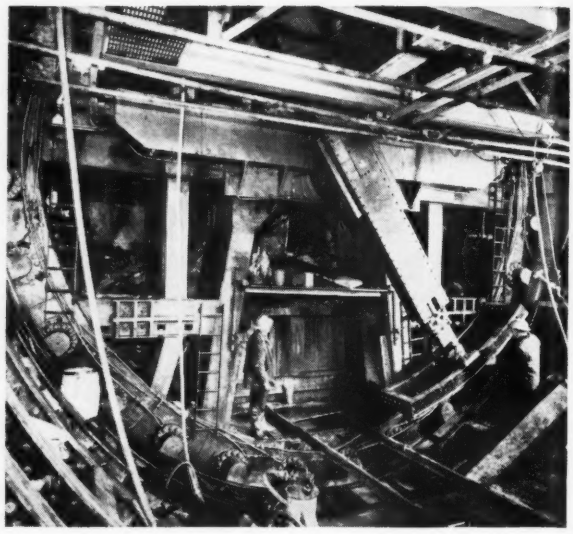


Air released from the muck lock causes condensation of fog on the free-air side of the pressure bulkhead. The man lock and emergency lock entrances can be seen above.

At heading, a conveyor carries muck to a hopper arranged to discharge to 6-cu yd cars on either track. Cars are handled by 8-ton battery locomotive.



Hydraulic hoist swings a liner section into position where the erector arm can pick it up for final placing.



Erector arm holds liner section while asbestos gasket is placed. Note hydraulic jacks for shoving and timber breast boards.

curred in areas of soft ground (clay). This squeeze has decreased the horizontal diameter of the tunnel as much as 2 in., the maximum occurring some 20 to 25 rings behind the shield. To counteract this condition horizontal pipe struts have been installed at the spring line. This distortion was anticipated by the designers and provided for in the specifications.

Construction problems

Problems of construction have been numerous in the tunnel excavation. Under normal conditions an underwater bore through clay requires an open-faced shield of the type designed by Perini for this contract. A somewhat similiar shield was used in the original construction of the old East Boston tunnel.

After the first tunnel was constructed, the ship channel into Boston Harbor was increased in depth from 32 ft to 42 ft below mean low water. In close proximity to the existing tunnel the dredging was carried considerably below the 42-ft depth. As a result there was practically no cover over the roof of the new tunnel.

To insure against blowouts and the loss of compressed air in the tunnel, permission was obtained from the U. S. Corps of Engineers to place a clay blanket over the tunnel site to provide a minimum cover of 20 ft, with the understanding that, when the tunnel driving is completed, the clay blanket will be removed and the original channel depth restored.

Driving of the tunnel is being performed from the East Boston ventilation shaft under city streets and residential housing, under Boston Harbor, and under commercial and residential areas in Boston, to the Boston ventilation building. The first 1,500 ft of tunnel driving was through very stiff clay, hardpan, and boulders. But as the shield approached Boston Harbor the ground changed to a soft blue clay. This required that the remainder of the work under Boston Harbor be performed under compressed air. An air-tight bulkhead was installed with a 10.5-ft x 65-ft muck lock, a 6-ft x 42-ft man lock and an emergency lock of the same size.

Driving under compressed air pro-

Equipment used on East Boston Tunnel

Compressor Plant

Low-pressure air:

- Two Ingersoll-Rand 5,000-cfm compressors
- Six Joy 1,000-cfm compressors (stand-by)

High-pressure air:

- Four Joy 750-cfm compressors

Hydraulic Supply, Water

- Two 28-gpm, at 6,000 psi, Worthington hydraulic pumps, each driven by a 100-hp motor
- One Watson-Stillman hydro-pneumatic accumulator, with 7½-hp air compressor and 500-gal tank

Electric Source

- Three separate incoming lines for 3,000-hp load
- Two 13,800-v lines at 3,000 kva
- One 4,160-v line at 1,200 kva
- Thirteen transformers

Shield

- Open type designed and fabricated by Alco Products
- Cast-steel cutting edge; three working decks; 31 ft 4 in. in diameter; 19 ft 6 in. in length including 8-ft tailskin
- Hydraulics, furnished by Watson Stillman Division of Farrell-Birmingham Co.
  - 28 shoving jacks, 200-ton, 10-in. ram, 40-in. stroke
  - 10 platform jacks, 96-ton, 6-in. ram, 40-in. stroke
  - 6 breast jacks, 50-ton, double-acting, 5-in. ram
  - Erecting arm and turning mechanism, 20-ton

Tunnel

- Length, 4,850 ft; excavation 150,000 cu yd
- Liner rings, Commercial Shearing and Stamping Co.
- Material lock, 10 ft 6 in. x 65 ft, Mayo Tunnel & Mine Equipment
- Man lock and emergency lock, 6 ft x 42 ft, Mayo Tunnel & Mine Equipment
- Mine cars, 6 cu yd, Mayo Tunnel & Mine Equipment
- Locomotive, General Electric, 8-ton, battery-operated
- Pea-shooters, 3½-cu ft capacity, Mayo Tunnel & Mine Equipment

gressed uneventfully until the East Channel line under Boston Harbor was intersected. At this point a considerable amount of river silt was discovered in the heading, extending several feet below the roof. Because of the presence of this silt and very soft clay, very little progress could be made using the conventional mining operations—clay knives and the like. At this point it was decided to blank off all shield pockets, with the exception of a small section of the lower center pocket through which muck could be directly placed onto the conveyor belt, and to shove the shield practically "blind." In this operation muck would be pushed ahead or to the side of the shield and only a small amount taken into the shield for subsequent removal.

Prior to this change, work was under 25 psi of air pressure. Shoving blind permitted a reduction in the air pressure to about 17 psi. It was very easy to move ahead. The immediate result was that the number of rings installed in a 24-hour day increased from four to an average of eight. It was then decided to blank the remaining small pocket and shove the shield completely blind, so that all the muck was displaced.

This method was followed to about the center line of Boston Harbor. At this point heavy gravel and boulders were encountered, which extended some 7 ft into the tunnel area. This changed condition required that the center pocket again be opened; mining in this center pocket required the use of clay spades and jackhammers for a distance of about 200 ft. The borings had predicted this condition and also indicated that the entire heading would again encounter very soft clay,

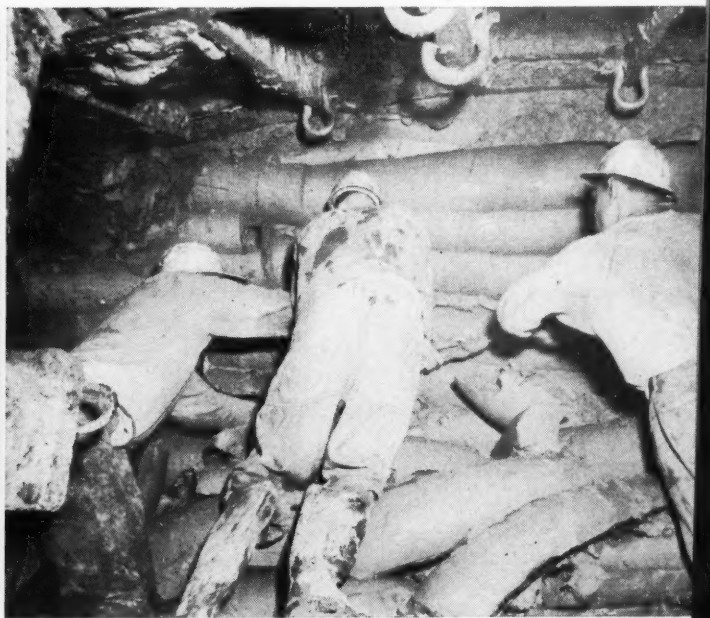
The lower center pocket was again blanked off and the shield shoved blind. This condition continued all the way to the West Channel Line under Boston Harbor. At this point, the front of the shield was entirely opened. Excavation is now expected to proceed with the use of clay knives, clay spades, and other air tools.

Shoving completely blind increased progress from an average of eight rings per 24-hour day to an average of 13.5 rings. In the peak day 18 shoves were made and 17 rings placed. While shoving blind, graveling and grouting outside the liner plate were eliminated because the soft clay was immediately squeezed back into the void left by the passing of the shield tail.

The uncertainties involved in building a tunnel make it impossible to anticipate all the problems that will be encountered, but detailed preliminary investigations will give some indication of the areas where difficulties will arise. One area that may prove difficult to pass through is under Lincoln Wharf in Boston. Here the preliminary investigation showed that the section of Lincoln Wharf to be passed under contains wood piles 50 to 60 ft long, which apparently reach down to 5 ft below the top of the shield. If this condition is encountered, the wood piles will have to be cut off and the area packed with clay to prevent loss of air.

Another problem inherent in constructing a tunnel of this size is the settlement that occurs as the tunnel passes. There is a space of 4 in. between the outside circumference of the shield and that of the liner rings, and it is imperative that this void be filled as quickly and as compactly as possible. This is done by forcing pea gravel and then grout into the void as soon as the liner ring leaves the protection of the shield. Even with this procedure some settlement occurs. As the tunnel is driven beneath buildings, streets, and utilities in the North End of Boston, a constant check will be made on the quantities and pressures of gravel and grout which are pumped into the voids. Any variance from the theoretical values will be carefully checked to determine the reason. On the surface, frequent checks will be made to detect any settlement, which might cause damage to buildings or utilities. When settlements are discovered, corrective measures will be promptly taken to prevent serious damage to structures.

(This article is based on the paper presented by Mr. Richardson at the ASCE Boston Convention, before a session of the Construction Division.)



Tough character of silt and clay is shown by backhoe bucket and sandhogs using knives at top of excavation where mechanical excavator would not work.

ASCE NEWS

National attack on water pollution

"Water Pollution is a People's Problem." This message was highlighted in opening sessions of the first National Conference on Water Pollution, held in Washington, December 12-14. Because it is a "people's problem;" because the understanding, support and cooperation of large numbers of people are essential to any effective abatement; and because public information is the channel to public understanding, the conference was a monumental effort to feed information into channels which reach the eyes and ears of "people." Many civil engineers were in attendance at this conference, and many were participants. The papers and discussions are an important part of the public information effort. However, if any came seeking reports on new developments in engineering technique, they were doomed to disappointment. It was just not that sort of a conference.

The "National Conference on Water Pollution" was requested by President Eisenhower, while he was in the process of vetoing the "Blatnik" Bill which would have extended federal efforts in pollution abatement. In his message the President stressed, "the mutual responsibilities of all segments of our society in cleaning up our waterways. We need appropriate action by Federal, interstate, State and local agencies," he said. "We need greatly expanded research, the continuing efforts of industry and agriculture and, most important of all, we need the wholehearted support of the individual citizen. It is the business of the Conference to study and assess the problem of water pollution in all its aspects and to develop goals and programs that will assure progress in this field."

Surgeon General Leroy E. Burney spelled out the theme of the conference: "Clean Water—a Challenge to the Nation." Then Frank A. Butrico, F. ASCE, serving as executive secretary for the conference, performed miracles of planning and preparation, which resulted in a remarkable gathering of nearly 1,200 invited representatives of every conceivable segment of our national life concerned with water pollution. Through these participants, it is hoped and anticipated that the urgent need for attention to this "challenge" will be carried to the individuals and groups of individuals—the "people"—who must understand and support.

Scope of the problem

Bringing to focus the extent of the pollution problems to be faced, Mark D. Hollis, F. ASCE, Assistant Surgeon General, and chief engineer of the U.S. Public Health Service, presented an engineer's report on the rapid extension of the pollution challenge and extended the demand curves into the future—to 1980, when "the urban population will be in the 200 million range. The population depending on surface streams for drinking water will be about 165 million. The sewered population will be at 200 million. Average streamflow will be the same. For most streams the pollutional shocks from partially treated waste will be cumulative—there will be little time for the stream to recover between such shocks. Distances between waste outfalls and water intakes will be closer and closer together. Hundreds of new-type, more persistent pollutants will further complicate the situation.

This gloomy picture does not include the industrial waste loading, which apparently no one is anxious to predict. Nor does it include "the impact on streams of non-sewered wastes—for example the residue from some 500 million pounds of synthetic pesticides produced annually for agricultural usage."

No longer can there be reliance upon relatively simple monitoring of the degree to which surface waters are "safe." In assessing the nature of the problem, Dwight F. Metzler, chief engineer of the Kansas State Board of Health and a member of the ASCE Sanitary Engineering Division, pointed his finger at the need to monitor viruses, chemical pollutants, radioactivity, silts, or minerals from irrigation return waters.

Priorities for water use

The scope of the problem, while staggering, lends itself to the sort of analysis and conclusion sequence to which engineers devote themselves. It was generally agreed that forms of "water management" must be organized. Clarence W. Klassen, director of the Illinois Division of Sanitary Engineering, suggested that we "maintain available waters in such physical, chemical, and biological condition that these waters will not create a nuisance or be harmful." To attain such objectives, Mr. Klassen proposed "the utilization of a stream based upon its ability to assimilate wastes," under physical and economic controls.

This was emphasized by Harvey O. Banks, F. ASCE, director of the California State Department of Water Resources, as he called for the establishment of "priorities for water use with waste disposal taking its proper place" among the necessary uses of water as well as water for recreation

Principals in conduct of Water Pollution Conference were (left to right) Mark D. Hollis, Assistant Surgeon General, Frank A. Butrico, Executive Secretary of the Conference, and Edward J. Cleary, Executive Director of the Ohio River Sanitation Commission and ASCE Representative on the Steering Committee

and for fish and wildlife resources. Or perhaps priorities for use of land should evolve, as indicated by the findings reported by Carl B. Brown, F. ASCE, of the Department of Agriculture. His paper called attention to the silt and salinity pollution from improper land use. As an example, he cited the Mississippi, which "carries an estimated average annual silt load of 500 million tons into the Gulf of Mexico."

Such establishment of priorities is not simple either, as was pointed out by Eugene W. Weber, F. ASCE, chief of the Planning Division of the Office of the Chief of Engineers. "Long-range river basin plans involve so many projects and so many functions that they tend to present flexibility to the point of aimlessness," he reported. "The ideal solution, nationwise, would be to undertake the most efficient projects first in order to maximize net benefits in use of resources."

Research and manpower needed

Perhaps for civil engineers the most rewarding part of the conference was that given over to study of research needs and the interrelated training of able personnel for the accomplishment of pollution abatement. In his discussion of research needs, Richard Hazen, F. ASCE, consulting engineer, states, "We must first attempt to establish quickly and as definitely as possible which of these compounds [detergents, synthetic chemicals, radioactive wastes, etc.] are truly harmful and their allowable concentration. We must catalog these wastes as safe or unsafe and set up a special category for the doubtful items."

There did not appear to be any concern that the capacity of the engineering profession to solve engineering problems was lacking—only that a very serious problem of enough money, enough manpower, enough public support continues, and does not show promise of early solution. This is treated in more detail in the February issue in the report of the panel that studied the critical needs for research, resources and training in this field.

The Conference Proceedings will be printed and made available.

The exacting jobs of Civil Engineers

By ADRIAN HAYWARD

The following article, reprinted from the "Worcester (Mass.) Telegram" of November 2, is about as fine a tribute to the profession from a layman as one is likely to read. From Mr. Hayward's little piece, which is entirely unsolicited, it may be inferred that public relations programs do some good.

The American Society of Civil Engineers was holding its annual convention in the Hotel Statler-Hilton in Boston. Watching its members and activities, I was reminded of a gesture of my clergyman father a generation or more ago. Somebody remarked in his bearing that "The future of the world belonged to the engineer." Believing deeply in the pre-eminence of spiritual forces, the cleric in my father shrugged. He didn't have to have engineering or anything material, to receive the highest rank.

If he could have glimpsed all that the personnel and interests represented there at The Statler-Hilton have accomplished, he would have seen the real meaning of the remark he hadn't liked. No need for jealousies between human life's interwoven interests! The engineers I have known have been for the most part deeply religious men. On the other side, historians have said that the Christian gospel conquered the world by marching to it along the roads built by those thoroughly competent civil engineers of long ago, the Romans. It may well be that today's engineering achievements are having no small share in the spread of spiritual forces over the world. They may have more.

Changed world

At any rate, for changing over the earth's surface—and that was what the remark quoted referred to—what have not those who are called "civil engineers" accomplished! I'm not informed enough to weigh them against the highest practitioners of other forms of technocracy—the inventors, chemists and physicists, practical manufacturers, who have had their share in transforming modern life.

But how different the world we all know would be if civil engineering hadn't been at work. Where would be the bridges, huge and small, but always so vital to us! Where that network of roads over the earth's surface! Where those heartening plans for restoring the centers of our cities to prosperity! Where the less conspicuous, but almost more essential services that have quickened, protected, embellished, in fact made possible modern living! Listed in the Statler announcements were such fields as soil conservation, sewers and sanitation, water power, tidal hydraulics, earthquake analysis, steel structures. They gave you just a sample of all the varied activities in which some sort of engineering plays a part.

Old view

In the sense of organized activity, I suppose engineers themselves would admit that theirs is a comparatively new profession. The ASCE was founded in 1852. I wasn't interested in such things as a boy and remember hearing another boy who felt the same way say, "I know of only two sorts of engineers, locomotive and stationary, those who run train engines, or who fire boilers in buildings." Others of our friends, however, knew the story far better and went away to Worcester Tech., rising to high positions and exciting tasks.

Spectacular

Civil engineering is perhaps the most spectacular of all engineering, if we rule out the developers of nuclear weapons. Civil engineering is in all ways humane—except, of course, when it condemns and drives you out of your home in order to build a new highway! We like what it does and we benefit immensely.

Sometimes it insists on taking a great liberty with Mother Nature as when it builds a Panama Canal. Sometimes it just shows you how to bring a driveway gracefully and prettily up to your front door. I was glad to get a glimpse there in Boston of the men and the ideals that are behind them.

Phoenix Convention to feature water resources

The weird beauty and mystery of the desert are dramatically spotlighted in this view.

ASCE members will find a Western —which is to say warm—welcome awaiting them on their arrival in Phoenix for the Society's Spring Convention, to be held at the Westward Ho Hotel, April 10-15. The host (Arizona) Section promises that nothing will be left undone to assure the engineer visitors and their families a memorable week.

Though the technical program theme will be water resources, actually nearly all the Society's fourteen Technical Divisions will be represented with one or more programs. In the numerous sessions devoted to the development and conservation of water resources, the five "Water Divisions" will deal with such areas of interest as: river stabilization, coastal aquifers, evaporation suppression, and multi-purpose projects. To supplement these sessions, field trips have been planned to the Aqua Fria power generating plant, the Squaw Peak water treatment plant, and Salt River Project installations.

Excursion to Glen Canyon Dam

An excursion highlight will be a two-day Post-Convention trip to Grand Canyon and Glen Canyon. Grand Canyon needs no build-up. Glen Canyon, also on the Colorado, is the site of a famous Bureau of Reclamation dam, now under construction. Upon completion, the concrete-arch dam will be over 500 ft high and 1,500 ft long. Glen Canyon Bridge, located just downstream from the dam site, forms a spectacular rim-to-rim highway. It is the highest and second-longest steel arch bridge in the United States.

To brief members on the dramatic Glen Canyon project, the Bureau of Reclamation is arranging an exhibit. A motorcade is expected to make the trip to Glen Canyon, only 275 miles from Phoenix over good highways. The tour will also take visitors into the heart of the National Park country, comprising Bryce and Zion Canyons in Utah as well as Grand Canyon in Arizona.

Conditions of Practice program

The Department of Conditions of Practice is arranging a varied program designed to appeal to a wide range of professional interests. For example, a panel from the Committee on Registration will discuss the differing views of ASCE and the National Council of State Boards of Engineering Examiners on the place of surveying in the registration laws. The same panel will also discuss the ASCE view on corporate practice. The Committee on Younger Members is planning a

Increased Use of Engineering Societies Library Reported

A marked increase in the use of the Engineering Societies Library in the past year is reported by Ralph H. Phelps, the director. According to Mr. Phelps, the increase indicates a continually growing awareness of the Library's value to the engineering profession. Orders received by mail from individuals and companies all over the world, for services such as literature searching, translating, and photoprint and microfilm copying, increased 25 percent over 1959. Requests received by telephone increased over 35 percent. Such non-visitor use now constitutes 68 percent of total library use.

In the past year the library has increased its number of volumes by 9 percent. It receives, by subscription, gift, or exchange, 3,400 periodicals and other serial publications—important in keeping engineers abreast of the current developments in their fields.

The Cataloguing Department catalogued more books and added more cards to the card catalog than in any one previous year. The Library Staff reviewed 691 books, providing book reviews for several publications, including those of the Founder Societies. Staff members have also devoted much time to planning the new Library facilities in the United Engineering Center. The Library, along with some two dozen other engineering organizations, will move to the Center when it is completed sometime in 1961.

Several books in the Engineering Societies Monograph series, sponsored by the Library and the Founder Societies, are being reprinted, and a new edition of a book, in the series, *Theory of Plates and Shells,* by Stephen P. Timoshenko and S. Woinowki-Krieger was published. Arrangements were made so that Xeroxed reproductions of out-of-print monographs are available from University Microfilms.

The Library has made outstanding contributions in the library field as well as in the field of engineering. "Alternatives to the Scientific Periodical; a Report and Bibliography" by Ralph H. Phelps and John P. Herling appeared in *UNESCO Bulletin for Libraries,* vol. 14, March-April, 1960, pp. 61-75.

symposium on the "Incompatibility of Unionism and Professionalism." There will also be a program on matters of professional interest, sponsored jointly by the Committee on Professional Practice and the Committee on Engineers in Public Practice.

The Arizona Section is emphasizing the opportunity for members and their families to make the Convention the occasion for a winter-end vacation in the "Valley of the Sun." From the weather standpoint, Phoenix is reputed to be at its best in April.

Activities planned for the ladies include a luncheon and style show, with the emphasis on Western attire; a shopping spree in nearby Scottsdale, "the West's most Western town"; and a tour through Frank Lloyd Wright's Architectural School. The wives will join their husbands for such events as the General Membership Luncheon, with Senator Barry Goldwater the featured speaker; a Western Barbecue at the Hotel Superstition Ho near the foothills of famed Superstition Mountain; and a dinner dance at the Phoenix Country Club. Those who do not see eye to eye with too much organized activity can laze around the heated pool and sunny patio of the headquarters hotel.

Hawaii Post-Convention Tour

Members with a bit of extra time could do no better than accept the Hawaii Section's invitation to a Post-Convention Tour in Honolulu and Waikiki. The dates for this visit to our new and beautiful state have been thoughtfully set for April 20 and 21, giving members a chance to linger in the Phoenix area a few days after the Convention.

Program in February issue

The wide choice of technical and social events in store for Phoenix Convention visitors will be available in the Convention program, to be published in the February issue. Since April is a popular tourist month in Arizona, members are urged to make their plans for attendance early, so they will be assured of the accommodations they want.

Though relaxed looking, these Arizona Section members are working hard for the success of the Phoenix Convention. Seated, left to right, are Committee members Glenn Bush, Clarence Whalin, Ed Waltenspiel, and General Chairman Elmer Maggi. Standing, in same order, are Leigh Gardner, Jake Doss, Jim Deatherage, Dwight Busby, and Bill Tizard.

EMC Reports Income of Engineering Teachers Up

The average total professional income of engineering teachers has increased by 14.7 percent in the past two years, according to a report by the Engineering Manpower Commission of Engineers Joint Council. The survey, made possible through a grant from the National Science Foundation, covers over 5,000 engineering teachers or more than half the total.

It was found that 77½ percent of the average total income of engineering teachers is basic teaching salary and the remainder derived from outside professional work such as consulting and research. Since the survey was first made in 1956, average basic teaching salaries have risen 31.1 percent and income from "outside sources" 11.3 percent.

Today's average basic teaching salary for engineering teachers in U.S. colleges is $8,534. It is supplemented by an average outside professional income of $2,479.

In public institutions the rise in total income (15.6 percent) was greater than that in private institutions (12.5 percent), more a result of higher outside earnings than of a difference in the rise of basic teaching salaries. Such outside earnings for engineering teachers in public institutions increased 24.8 percent during the past two years as opposed to only 11.3 percent in private institutions. The basic teaching salary increase was 13.4 percent (public) compared with 13.0 percent (private).

Other statistics of the report show that salaries increase with age, academic rank, and type of degree; that the median teaching salary for instructors in $5,380, for full professors, $10,500.

Salaries and Income of Engineering Teachers—1960 is the title of the report. The survey was conducted in cooperation with the American Society for Engineering Education and prepared for the Manpower Commission by Prof. Morris A. Horowitz, of the Bureau of Business and Economic Research, Northeastern University, Boston. It is available from the Engineering Manpower Commission, 29 West 39th St., New York 18, N. Y., at a cost of 25 cents.

(More ASCE News on page 71)

Lime stabilization cuts runway costs

ARNOLD R. KELLEY, Construction Engineer, Public Works Department, City of Austin, Tex.

Broken up asphaltic pavement and old gravel base—mixed in place with a lime slurry—has been economically used as a subbase for a major runway at Austin, Tex. By this means a considerable saving was realized in reconstructing 4,200 ft of an instrument-landing-strip runway 7,300 ft long and 150 ft wide at the Robert Mueller Municipal Airport. The old material, stabilized with 3 percent by volume of hydrated lime, serves as the subbase for the new 4½-in. flexible base course and the 2-in. hot-mix pavement.

Much of the distress in the old pavement was due to inadequate support both from the black clay loam subgrade and from the 12-in. caliche-gravel base course. The latter was quite plastic and porous and had taken on considerable moisture. Tests indicated that this material had an average plasticity index of 11, and its density was less than 85 percent, as determined by the Civil Aeronautics Administration (CAA) compaction control test T-611.

Before the stabilization project was started, considerable laboratory testing was done to determine how well lime reacted with the in-place gravelly material. Results are shown in Tables I and II. In Table I it is of interest to note that the lime agglomerates or solidifies the smaller particles, thereby reducing the percentages of the upper-limit sizes.

From these tests it can be seen that lime reduced the plasticity and volume change considerably, and made the soil much harder and more stable. According to the Texas triaxial test, the soil was actually upgraded from a Class 2.8 material (a borderline base) to a Class 1 material (a good flexible base).

Cement and asphalt were considered as stabilizing agents but were eliminated because of cost.

Alternatives to stabilization would have been: (1) to excavate the unsatisfactory base material and replace it with 18 in. of flexible base (as was done on a 3,100-ft extension), or (2) to add a new flexible base, without excavation, which would have undesirably raised the grade. Since these alternatives would have been considerably more costly than stabilization, the decision was made to build an 8-in. stabilized subbase and a new 4½-in. crushed-stone base. Actually the bottom 6 in. of the old gravel base was left intact, and the top 6 in. of the base and the old 2-in. pavement were mixed together, making a total of 8 in. of stabilized material. A new hot-mix pavement and seal coat rounded out the design. The stabilization was done at a bid price of 55 cents per sq yd, which included the cost of lime, manipulation, water, and asphalt emulsion seal.

TABLE I. Physical constants for lime-reaction tests

	Raw Soil	3 percent of Lime Added
Gradation:		
Passing 2-in.	100.0	100.0
Passing ¾-in.	95.4	99.5
Passing ¼-in.	74.2	57.5
Passing 40-mesh	35.6	18.0
Passing 200-mesh	24.6	0
Liquid limit	24.7	31.5
Plasticity index	11.0	6.5
Lineal shrinkage	5.9	3.15

TABLE II. Stability by Texas triaxial test*

	Raw Soil	3 percent of Lime Added
Dry density, pcf	133.7	130.2
Lateral pressure:		
0 lb	29.5 psi	182.6 psi
5.7 lb	84.7 psi	241.1 psi
15.7 lb	147.4 psi	342.4 psi

* Involves an 18-day curing period, including 7 days of moist curing, 8 hours of oven drying at 140 deg F, and 10 days of moist curing (in capillarity).

Lime slurry used

One interesting feature of the project was the use of lime slurry rather than bulk hydrated lime to reduce dusting and to effect uniform distribution. The slurry was prepared in a riveted storage tank 10 ft in diameter and 30 ft high, with a capacity of 17,000 gal. The mixing ratio was 1 ton of lime to 500 gal of water, which made up 700 gal of slurry (32 percent solids). A typical batch was 17 tons of lime (one bulk truckload) to 8,500 gal of water, although the tank could handle up to 20 tons (about 14,000 gal) of slurry.

Mixing was accomplished by a 4-in. recirculating pump and compressed air supplied by a 365-cfm compressor. The pump was used both to recirculate the slurry and to load the tank trucks. The air was distributed throughout the slurry by a perforated pipe positioned 8 in. off the bottom of the tank. In addition, the contractor devised a hand-operated air scraper for preventing sedimentation in the tank. During charging, the air jets were on at all times. After all the lime was dumped in, the recirculating pump was turned on. A tank full could be mixed in 20 to 25 minutes. It took 15 minutes to load the 4,600-gal water trucks. On the job the slurry was spread through a 4-in. gravity spray bar drilled with ¾-in. holes. To eliminate the possibility of uneven distribution, the truck made two passes with each load, that is, up and back. A typical lane was 1,500 ft long by 150 ft wide—the width of the runway. Up to 100 tons of hydrated lime, or about 70,000 gal of slurry, were handled in a 10-hour working day using two water trucks. The slurry plant represented a modest investment of only $1,000.

Construction program

The construction procedure was as follows. The old 2-in. asphalt mat was ripped up with an Allis-Chalmers AD 45 grader-scarifier, after which a self-propelled Seaman Pulvimixer made one pass to break up the lumps. Then an Allis-Chalmers crawler tractor, fitted with a back ripper, scarified the runway another 6 in., followed by two passes of the Pulvimixer to assure uniform base materials. Specifications called for all of the material to pass a 2-in. screen with 2-in. square openings. The base was then rolled lightly and graded smooth—to prevent the slurry trucks from getting stuck. However, before the lime was spread the contractor used a spring-tooth harrow to furrow the surface, thereby preventing the slurry from running off.

The slurry application, totaling

23.4 lb per sq yd, and the mixing were done in two stages. Had all the slurry been spread in one operation, the soil would have been too wet to work. The procedure was to apply half of the slurry requirement, followed by a spring-tooth harrow and two Pulvimixer passes to the full 8-in. depth. Then the material was allowed to dry for 4 to 12 hours. Next, the subbase was rolled lightly, bladed, and furrowed with the cultivator, followed by the second slurry application. Final mixing was completed with two or more passes of the Pulvimixer, which again distributed the lime throughout the 8-in. layer.

Compaction was done immediately after the second mixing, first with the Bros pneumatic-tired roller, making one or two passes, followed by the Vibrapac vibrating roller. The latter, operated at 1,600 vibrations per minute and 2 mph, compacted the full 8 in. to 95-percent CAA density or greater in only four passes. During final rolling, exceptionally wet spots were aerated with the Pulvimixer. There was no problem in attaining high density; in fact, the average compaction was 97 percent.

Following compaction, the surface was kept damp until an emulsified asphalt seal of 0.1 gal per sq yd was applied. The seal served to prevent the subbase from drying out prior to placement of the stone base. Specifications called for the base course to be placed either the same day the subbase was completed, that is, before hardening started, or after the lapse of at least seven days, to avoid cracking of the partly hardened subbase. The Class 1 base material used had the following gradation:

Sieve Size	Percentage Passing
1 in.	70-100
¾ in.	60-90
⅜ in.	45-75
No. 4 mesh	30-60
No. 10 mesh	20-50
No. 40 mesh	10-30
No. 200 mesh	5-15

Like the subbase, the base was compacted in one lift to not less than 95 percent CAA density, using pneumatic and Vibrapac rollers.

The surface course consisted of 2-in. to 3-in. hot-mix asphaltic concrete (3-in. on the taxiways and at runway intersections), and a seal coat of OA 130 (0.18 gal per sq yd) and ¼-in. white crushed stone (11 lb per sq yd).

Durability experience

Since its completion in the spring of 1959, there has not been a single failure on the entire 4,200-ft section, nor has any cracking developed. On the other hand, the 3,100-ft extension to the runway completed in 1958, using conventional design, has developed numerous cracks. Samples recently taken from the lime-treated section indicate increased hardness of the subbase.

Because of the success of the Austin project, the city is planning to lime stabilize its north-south runway, 4,700 ft long, which is in need of rehabilitation. Funds are available, and plans are being prepared for construction early in 1961.

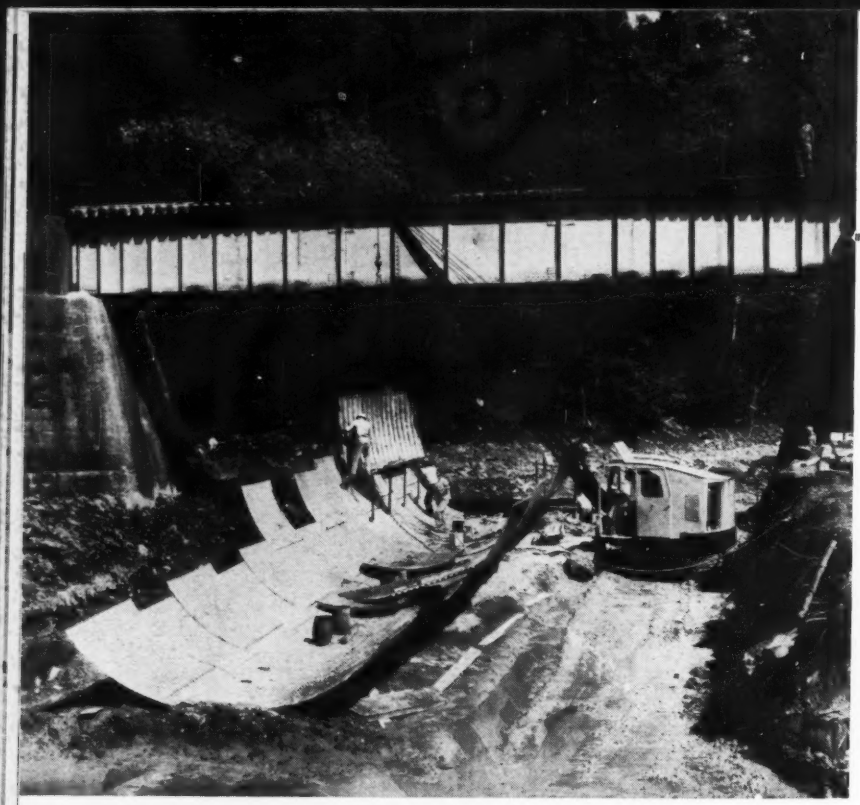
The entire project consisted of about 89,000 sq yd of lime stabilization and new pavement. The contractor was the Giesen and Latson Construction Company, Austin, Tex., headed by Noble E. Latson and Ed Giesen, partners. Robert Giesen was in charge of construction.

Key city officials involved in the project were W. T. Williams, Jr., city manager; S. Rueben Rountree, Jr., director of public works; Robert Beckam, assistant director of public works; and Arnold R. Kelley, construction engineer, who directed the project.

Slurry was applied in two stages of 11.7 lb per sq yd each. Rake harrowing followed application of slurry to minimize runoff.

After first slurry application, two passes were made by the Pulvimixer, then the material was allowed to dry for 4 to 12 hours before the second application of slurry.

Pulvimixer is making final pass followed by vibrating roller. On right is seen completed stabilized subbase.



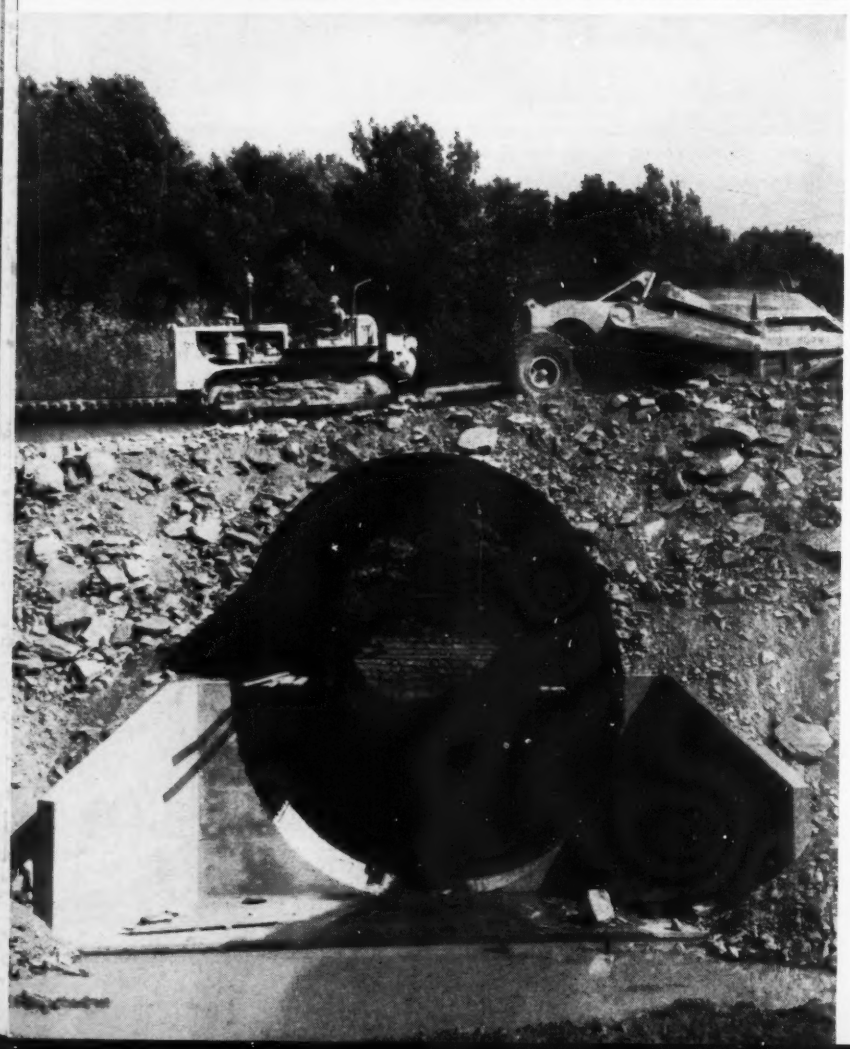
Crawler crane handles sections of Armco 1-gage Multi-Plate for culvert to replace steel-girder bridge on Louisville & Nashville Railroad. Plates are bolted together with pneumatic wrenches.

A metal culvert of the largest diameter ever placed under a main-line railroad in the United States has just been completed by the Louisville & Nashville Railroad Company at Independence, Ky., about 15 miles south of Cincinnati. This huge culvert of corrugated structural plate is a 5-percent vertical ellipse, giving it a vertical rise of 21 ft and a horizontal span of 19 ft. It is 100 ft long and covered by fill 14 ft deep at the top.

A considerable saving was realized by designing and building the structure according to a theory that analyzes an embedded pipe as a ring in compression. Successful application of the theory on a number of major installations, plus extensive Armco research, points toward much broader use in the future of corrugated metal structures of large diameter.

The theory involves a method for determining gage thickness in relation to the size of the structure and the depth of cover. Practical application of the theory has established that round corrugated metal structures can be built considerably larger and of much lighter-gage steel than was previously thought possible. In addition, the theory has led to the conclusion that pipe-arch shapes can withstand loads equal to those of round structures, indicating that still larger pipe arches of lighter-gage steel are practical. The latter development is particularly significant because pipe arches represent nearly half of all structural plate corrugated metal structures.

The Armco Multi-Plate culvert at Independence, Ky., is part of a railroad bypass 1,800 ft long that eliminates an old masonry-lined tunnel and two bridges. The structure consists of



Tractor-drawn carrying scraper spreads fill on top of culvert with a vertical rise of 21 ft. Full height of cover is 14 ft. Horizontal cables were installed across inside of pipe to maintain its shape, but balanced backfilling made them unnecessary.

Largest metal culvert designed by ring compression theory

HOWARD L. WHITE, F. ASCE, Chief Sales Engineer, Armco Drainage & Metal Products, Inc., Middletown, Ohio

13 rings, eleven 8 ft wide, and two 6 ft wide. The one-gage plate sections were erected by a small crane and bolted together with pneumatic wrenches.

Backfilling, which is a critical factor in ring compression design, was carefully controlled. About 1,600 yards of bank-run gravel was delivered by gondolas and dumped through openings in the bridge to be replaced. A loader spread this material around and close to the structure in 6-in. lifts. Pneumatic tampers compacted fill under haunches and between corrugations, while a gasoline-engine-powered vibrating compactor worked the area several feet out from the pipe walls. The remainder of the backfill consisted of earth and blasted shale and was spread and compacted by tractor-drawn pans.

Horizontal cables installed across the inside of the pipe to maintain a 5-percent ellipse proved unnecessary. Good compaction along the sides of the structure prevented any distortion, even when the cover reached its full height.

Development of the theory

Development of the ring compression theory, which follows, reveals how it was possible to design and install this structure, which is far larger and lighter than those shown in present handbook tables.

The normal corrugated metal conduit is designed to have sufficient moment strength to withstand the stresses imposed by handling and installation. Once it has been installed in a compacted backfill capable of taking reaction pressures, the corrugated metal conduit can then be analyzed as a thin ring in compression. The forces that tend to crush the ring are those dealt with in development of the theory, inasmuch as these forces determine the required metal thickness and the seam strength under normal loading conditions.

The primary factor in the normal corrugated metal conduit is compressive strength. It is possible to demonstrate the relationship between moment strength and compressive strength by the use of engineering formulas; however, the most significant conclusion is that there is a considerable difference in strength. In metal conduits the compressive strength far exceeds the moment strength.

When equally heavy radial forces are applied completely around the periphery of a corrugated metal conduit, the structure will remain round under the application of a heavy concentrated force. It is conceivable that the corrugated metal conduit, once installed in the ground and subjected to the loads of normal backfilling and additional live loading, will retain exactly the same shape it had when it left the factory.

This has occurred in a number of cases. Backfill has been compacted so as to increase the vertical elongation of the structure by the same amount that the cover load eventually decreased it. The stresses created within the structure, under these conditions, are those of compression within the ring—none of the moment strength of the structure is being utilized to support final loads.

Compression within the ring is equal to the intensity of the normal pressure times the radius of the structure. This is the algebraic reverse of the formula used for computing the hoop tension in a pipe subjected to uniform internal pressure.

Extensive study has revealed that the best approximation of a working load can be expressed as follows: The intensity of the external radial pressure exerted on a conduit under backfill is equal to the height of the fill times its density. To this dead load should be added the distributed pressure of the live loading.

In the case of the Independence, Ky., structure, live load acting at the plane tangent to the top of the structure is 750 lb per sq ft, based on Cooper E72 loading. The dead load is computed by multiplying the height of cover, 14 ft, by the density, 120 lb per cu ft. The result is 1,680 lb per sq ft, or a total live and dead load of 2,430 lb per sq ft.

Since the ring compression, C, equals the intensity of normal pressure, P, times the radius (or one-half the span if it is not a circle), $S/2$, then

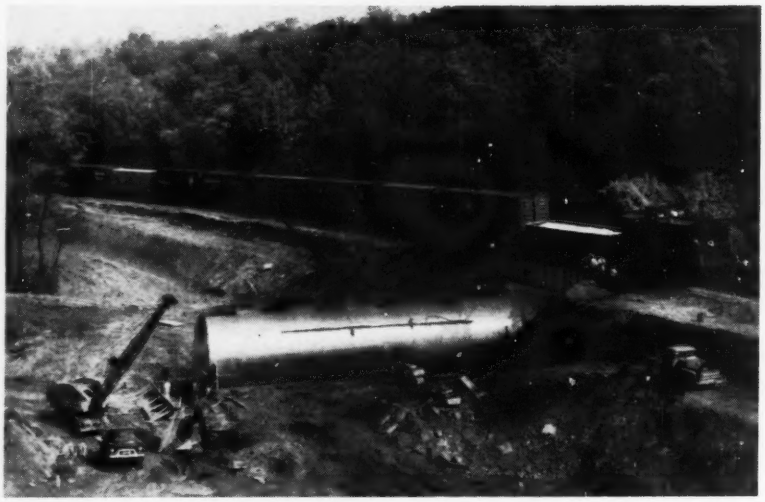
$$C = 2{,}430 \text{ psf} \times \frac{19 \text{ ft}}{2}$$
$$= 23{,}085 \text{ lb per ft}$$

Assuming 1-gage steel plate for the structure under 14 ft of cover, experimental data reveal an ultimate strength of 144,000 lb per ft, or a very conservative safety factor of more than six.

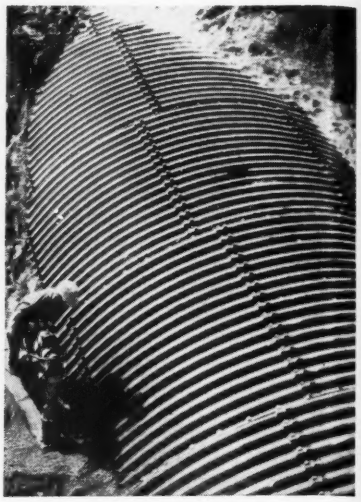
Preparing the foundation

The actual normal load on a structure will vary considerably in accordance with the method involved in preparing the foundation and backfill. Soft foundations under a structure, with hard foundations at each side, serve to decrease the load on the structure. Hard foundations underneath a structure, with soft foundations on the sides, tends to increase the load on the structure. A uniform foundation underneath and at each side of a structure, subjected to compaction at the side of the structure such that deflection amounts to a minimum, tends to make the load on the structure equal to the height of cover, or the column of material plus superimposed live loads.

As indicated previously, compression within the ring has been determined by multiplying the radius of the ring times the normal pressure on the ring. The assumption is that this normal pressure is equal to the height of the cover times the density, plus the distributed live load when appropriate. The intensity of the live load distribution to be added to the dead load, it is logical to assume, is the intensity at the plane across the top of the structure. Assuming this, the vertical component of the compression can be



Erection of culvert under Louisville & Nashville Railroad nears completion. Bank-run gravel is dumped from gondola car through the existing girder span. The gravel is compacted to provide well-draining backfill around the pipe.



Wacker compactor with pad 10 in. square works close to pipe. Good compaction is vital in ring-compression design.

computed by taking one-half the span of the structure and multiplying it by the height of cover times the density, plus the distributed live load. This is important, because it gives the compression in the ring for structures of shapes other than circular in which the span occurs at the point where the conduit wall is vertical. See Fig. 1.

Since this compression exists throughout the structure (except for the effect of friction), any small part of the arc could be removed from the structure as a free body, with its part of the load and the compression vectors on each end. This furnishes a means of computing the compression in a corrugated metal arch having sufficient cover. The compression becomes the tangential reactions furnishing the horizontals and verticals necessary for abutment design.

It is necessary to determine what amount of cover over a particular structure is required in order to turn it into an essentially compressive structure. During installation, the structure must contain enough moment strength to resist the forces of handling and compaction of the earth against it. Once fill has been placed to the top of the structure, additional fill begins to exercise pressure on the top so as to reduce the requirement for moment strength.

At some point above the structure, this fill reaches an amount which exactly overcomes the active lateral pressure on the structure. At this point, the structure becomes a compression ring. The height of cover necessary to accomplish this is approximately one-quarter of the diameter of a round structure (or one-half its radius). This has been determined from analysis of the normal components of the active pressures on a structure, using the active component of the vertical weight as one-third. In practical application, this amount can be reduced to at least one-eighth of the diameter, because the structure does contain moment strength.

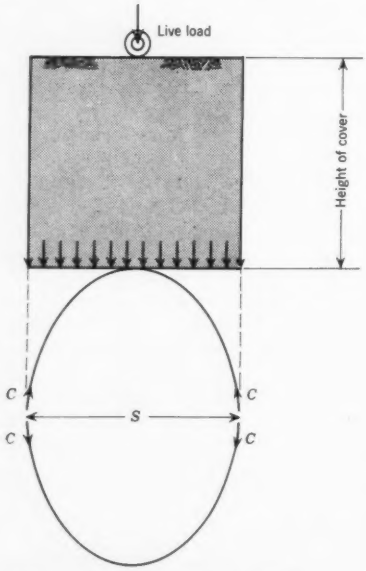


FIG. 1. Compression in the ring is shown for structures other than circular.

$C = P\,(S/2)$ where C = ring compression; P = unit live load plus dead load; and S = span.

There is a vast difference between the compressive strength for a conduit and its moment strength. Compressive strength provides the basis on which the design data are developed. However, it must be noted that this is only an accurate approximation since our knowledge of earth pressures and reactions is generally not sufficient to provide a great degree of precision.

At any plane section taken transversely through a conduit, the forces operating on any point of this transverse section can be represented completely by two mutually perpendicular

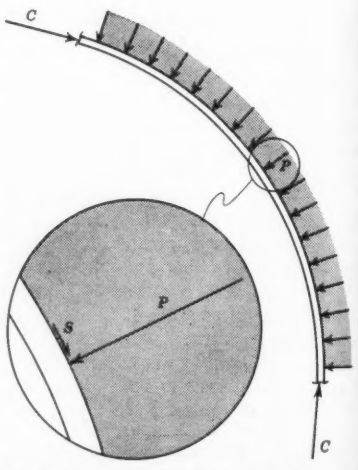


FIG. 2. Force at any point on culvert is represented by two mutually perpendicular vectors. Tangential force, S, will depend on relative motion between conduit wall and soil.

vectors. If one of these vectors is chosen as radial, then the other will be tangential and will represent the friction force of the soil on the conduit. See Fig. 2. This force may or may not exist, depending upon whether or not relative motion between the two is impending. In any case, it is limited either by the friction coefficient of the soil on the structure or by the shear within the soil itself.

It has been noted previously that any small part of the arc of a circular structure can be removed as a free body. Applying this principle to an elliptical (oval) structure, a very close approximation of the compression within the ring and of the distribution of the soil reactions around the ring can be made. Assuming that the structure carries the entire height of cover, the compression can be computed by taking the height of cover times the span times the density and dividing it by two.

Normal forces

It is possible to determine the normal forces on each arc of the structure by utilizing the formula which states that the normal forces on a circular arc times the radius of the arc equal the compression. Since the top arc is smaller in an elliptical structure than it would be in a round one, it is to be noted that the pressures on this arc will be very slightly more than those obtained from the formula that the compression equals the height of cover times the density.

If the arc covered 180 deg, as it does in a half-circle arch, the pressure would exactly equal the height of cover times the density. Some passive reaction above the structure is permissible. In turn, it is noted that the pressures on the side arcs of larger radii are considerably less than they would be for a round structure of the same periphery.

This illustrates why the elliptically formed structure suffers less vertical deflections under the same fill loading than a round structure. The same process of calculation can be applied to a pipe-arch structure. In addition, one more radius in the top plates forms an underpass shape for which the same analysis is valid.

Backfill material

This method of approximating the compression within the ring of a metal conduit makes it possible to balance the compression against laboratory tests of the same strength. The pressure distribution provides the soils engineer with data from which to determine what type of soil will be needed around structures of various shapes to insure support without undue deformation. See Fig. 3.

Under normal conditions, the fill material will weigh up to an extreme of possibly 130 lb. Tests, sponsored by the American Railway Engineering Association at Farina, Ill., have revealed that the pressure on the top of a corrugated metal conduit, under normal conditions of installation, may be as low as 60 percent of the height of cover times the density. It is considered conservative to use the density of the soil above the conduit as amounting to 100 lb per cu ft and to use the entire height of cover. When this height of cover, with the density of 100 lb per cu ft, is multiplied by four (the safety factor) and balanced against the compression strength of the seam, then the thickness of the conduit metal will be as given in most handbook publications.

Although it would be desirable to know in precise terms the compression under which a corrugated metal conduit would fail by compressive buckle, such exact information does not exist. Timoshenko's analysis for the buckling of circular rings under external pressures cannot be precisely applied to structures involving earth backfills; earth does not behave in the same manner as water.

Some laboratory model tests have indicated that the ultimate compressive strength in earth might be on the order of 10 percent less than the yield strength of the metal. However, the data are not sufficient for use with any certainty. Practical reasons demand a safety factor in excess of this; computations on ultimate collapse are of little value except in extremely hazardous conditions such as are associated with blast loadings. For carefully controlled and well engineered installations, a safety factor of two based on the same strength has been found adequate. Where there is a chance of average backfilling practice, a safety factor of four is considered appropriate.

A formula has been developed to determine the moment strength necessary for average conditions of handling, installation, and backfill. It is:

$$K = D^2/I$$

where

K = degree of flexibility
D = diameter in inches (or periphery in inches divided by π
I = moment of inertia of the pipe wall

It is to be noted that, if the structure is an underpass, ellipse or pipe arch, D is expressed as the periphery divided by π.

On the Independence, Ky., job, the R. C. Durr Construction Company of Walton, Ky., was the contractor. Inspection on the job was done by the bridge and track supervisory officers of the Louisville & Nashville Railroad Company.

Behavior of a metal conduit as a thin ring in compression is demonstrated by the author, Mr. White. Behavior of a coffee can with ends removed simulates that of metal conduit. When partially restrained by blocks, it will withstand the weight of a man or puncture by a nail without deformation. Outside the blocks, however, coffee can has little strength.

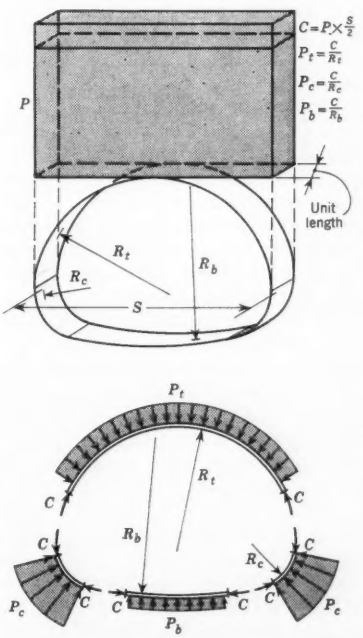


FIG. 3. Typical loading and pressure diagrams are given for a pipe-arch structure.

$C = P\ (S/2)$; $P_t = C/R_t$; $P_c = C/R_c$; $P_b = C/R_b$

The 1960 Conference on

The Conference on Civil Engineering Education, held at the University of Michigan, Ann Arbor, Mich., July 6-8, 1960, was sponsored by the American Society of Civil Engineers, The Cooper Union for the Advancement of Science and Art, the American Society for Engineering Education, and the National Science Foundation. It was attended by some 250 educators, practicing engineers and industrialists from all parts of the country. A review of the Conference appeared in CIVIL ENGINEERING for August 1960, p. 106. This article is based on papers presented at the ASCE Boston Convention, before a session of the Department of Conditions of Practice.

Why the 1960 Conference on Civil Engineering Education? Obviously the primary purpose was to bring together the most widely representative group of civil engineering educators ever assembled for the sole purpose of examining the educational process by which young men are brought into the profession.

Such introspection in the field of engineering education, however, does not necessarily reflect present failure or portend future crisis. It is an activity that has been fruitfully pursued almost continuously since the 1920's.

Much of the 1960 Conference dealt with the impact of the 1955 Report on Evaluation of Engineering Education which had called for greater emphasis on the scientific orientation of engineering education. Although this feature of the ASEE Report has received widespread adoption and approval in all branches of engineering education, it is also the part that has posed problems which have seemed to be especially difficult in civil engineering curricula.

Perhaps of more immediate concern to the 1960 Conference were the opinions expressed in the 1958 Report of the ASCE Task Committee on Professional Education. One of the most startling revelations of this latter report was that two-thirds of the total membership of ASCE favored extending the college curriculum to five years of undergraduate study. Educators, on the other hand, opposed extension of the curriculum beyond four years by about the same margin. Careful appraisal of these results indicated that the reasons advanced for the five-year curriculum were varied and in some instances even contradictory.

Opinion Research Inc. staff who made the 1958 survey concluded that: "Seemingly some greater unity of aim and purpose must be achieved among engineering educators if any progress is to be made in civil engineering education. Educators must somehow be brought together to air their differences and achieve a more unified point of view."

Another disconcerting note frequently discussed is that of apparent declining freshman enrollments and the fact that civil engineering appears to have lost ground in respect to other branches of engineering, especially in attracting the abler students. In this connection it is well to review other than enrollment statistics before jumping to conclusions. Another vantage point is that of the number of degrees awarded. See Table I, which covers the past 50 years.

Note that while there has been a sharp decline in civil engineering degrees awarded since 1949-1950, the peak of veteran graduations, the present annual rate is still several times that of pre-World War II. Also note that the present ratio of graduate degrees per year is now 1:5 as compared to 1:20 in the era of 1930 and the almost insignificant ratio of 1:100 back in 1910. These favorable trends in "degrees granted" may be more significant than the usual undergraduate enrollment statistics so frequently quoted.

When the 33,584 bachelor's degrees of engineering awarded in 1959 are viewed in respect to the number of accredited curricula, another point can be made. The present distribution in the three major fields seems to be:

Curricula	No. Accredited	Degrees	Degrees per Curricula
Civil	141	4,939	35
Mechanical	141	8,300	59
Electrical	145	9,837	68

These statistics would indicate that, as compared to mechanical and electrical, there certainly is more than an adequate number of accredited civil engineering curricula. This may even suggest that some curricula of marginal quality could be eliminated without seriously jeopardizing the number of opportunities for obtaining a civil engineering education.

With the profession well aware of the need to increase the technical as well as the professional competence of civil engineers, it may well be that the means for attracting the bright and able young men into the field will be through greater flexibility in curricula to suit the individual interests and capacities of students.

Into this atmosphere of doubt and uncer nty a widely representative group f 30 ASCE members moved in the winter of 1960 as a study and planning committee. This committee identified a wide range of questions as suitable for discussion at the conference. These included the following:

1. What are the career areas and distinguishing functions of a civil engineer and what is the unifying theme of civil engineering?
2. What are the broad educational concepts that enable the civil engineer to perform these functions properly?
3. Recognizing that education is a continuing, lifelong process, what goals should be aimed at in the undergraduate civil engineering program?
4. Is bifurcation desirable, for example as between professional and technical or as between design and research?
5. What is the most desirable organization of a civil engineering educational program?
6. Should professional civil engineering study be preceded by some form of college-level preprofessional or pre-engineering program?
7. How much of the preprofes-

TABLE I

Earned degrees conferred in civil engineering, continental U.S.

Academic Year	Bachelor's and First Professional Degrees	Master's and Second Professional Degrees	Doctorates
1901-1910	586[1]	5	..
1919-1920	1,094	68[1]	..
1929-1930	1,977	103[1]	..
1935-1936	1,883	216	8
1949-1950[2]	7,781	689	28
1959-1960 (est.)	4,800	1,000	40

[1] C. E. degree
[2] Includes outlying parts of the U.S.

Source: Annual Report of the Commissioner of Education, 1910; and Biennial Survey of Education in the United States, 1918-1920, 1928-1930, 1934-1936, 1948-1950.

Civil Engineering Education

WILLIAM P. KIMBALL, F. ASCE, Dean, Thayer School of Engineering, Dartmouth College, Hanover, N. H.

CORNELIUS WANDMACHER, F. ASCE, Associate Dean of Engineering, University of Cincinnati, Cincinnati, Ohio

sional or pre-engineering program should be common for all engineers or for all civil engineers?

8. What might be the advantages, disadvantages, consequences and chances for success of such an educational pattern in engineering?

9. How much specialization should be included in the curriculum, in what areas, and at what levels?

10. Can a man who has studied only one specialized area of civil engineering be identified as a civil engineer?

11. What is the place of mathematics and of scientific principles in the curriculum and how can they best be utilized to the fullest extent?

12. How can a professional attitude be instilled in students?

13. What criteria can be used to determine what part of the total education and training for civil engineers should take place in college and what part on the job?

14. What is the place of the technician in civil engineering practice and of technician training in the engineering school?

15. How can the best students and the best faculty be identified and attracted to civil engineering, and what part can ASCE, ASEE and ECPD play in this effort?

After these questions were considered by four study groups, discussions were held by the planning conference as a whole, which led to the adoption of the following resolution:

"WHEREAS the report of the ASCE Task Committee on Professional Education, published in 1958, revealed that a large proportion of the membership believes that contemporary civil engineering education falls far short of meeting contemporary needs, and

"WHEREAS two-thirds of the membership favors extending the period of undergraduate study to five years, and

"WHEREAS the work of the civil engineer is becoming increasingly interwoven with and vital to man's economic, political, and social well-being, and

"WHEREAS modern technological developments are ever widening the vistas of civil engineering and deepening its scientific roots, and

"WHEREAS these trends are constantly accentuating and creating needs that can be met only by truly professional people whose education has the breadth of a liberal education and the depth of a firm foundation in mathematics and science, and

"WHEREAS professional education can fully realize its objectives only as it can grow out of the breadth and depth of preprofessional studies, and

"WHEREAS a learned profession will grow and prosper in proportion to the creativity and vision engendered by continuing research and study at its frontiers,

"Therefore be it resolved that this conference favors the growth in universities and colleges of a pre-engineering, undergraduate, degree-eligible program for all engineers, emphasizing humanistic-social studies, mathematics, basic and engineering sciences with at least three-quarters of the program interchangeable among the various engineering curricula; to be followed by a professional or graduate civil engineering curriculum based on the pre-engineering program and leading to the first engineering degree, with a civil engineering degree awarded only at the completion of the professional or graduate curriculum, and

"Be it further resolved that increasing opportunities should be provided for qualified students, by progressively more advanced study and research, to earn graduate degrees at the master's and doctor's level, and

"Finally be it resolved that engineering societies in ECPD and EJC be advised of this resolution and be urged to support it by concurrent resolutions in order that unified action will be taken to secure a truly professional educational base for professional engineering practice."

The full context of the 20 papers and prepared discussions which dealt with these and related questions occupy some 200 pages in the final report of the conference. The summary that follows attempts to present the highlights of the conference for the benefit of those who will not have adequate opportunity to review the complete report.

New concepts, new ways

In the keynote address[1] it was stressed that many of the old distinctions between the traditional branches of engineering have vanished and that a whole host of new interdisciplinary problems will need to be tackled by closer cooperation not only among the various branches of engineering but also within well-integrated engineering and science teams.

To meet these challenges it was suggested that some new curricula may be needed and also that greater flexibility in curricula will be essential to meet the individual interests and capacities of students.

Preparation for these changes of curricula may not require new courses as much as it will require new ways of handling present courses in order to introduce new concepts.

Focusing attention on the place of the technician in civil engineering brought out the recommendation that there be no hesitancy in surrendering to the technical institute such training as is now the rightful province of such an institute. Otherwise, civil engineering curricula that are maintained generally as they were when there were no technical institutes may soon be classified formally as technical institute curricula.

Definition of civil engineering

When the question, "What is civil engineering?" was tackled in the early stages of this conference, a truly satisfactory answer was found lacking. Five current areas of outstanding challenge in the scatter of civil engineering activities were identified as: obsolescent structures, traffic congestion, water shortages, air pollution, and radioactivity by-products. Accordingly it was proposed that the unifying theme is:

The fulfillment of human needs through the adaptation and control of the land-water-air environment.

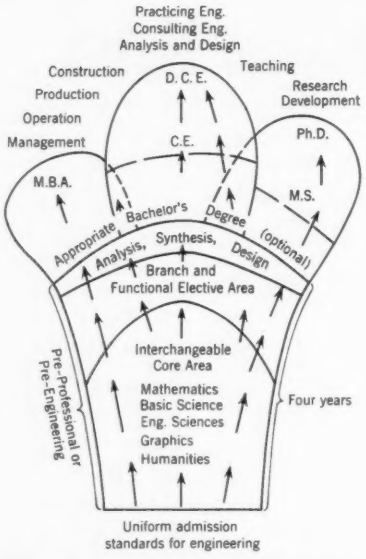


FIG. 1. Possible flexible plans for building on the "interchangeable core." "Interchangeable" is here used in the sense that all courses in the "core" are identical for all engineering students and fully acceptable in any department that grants engineering degrees. "Core" courses take three-quarters of four years but not necessarily the first three years.

The case for this new and simple definition of the objectives of civil engineering is well documented[3] and worthy of much rereading.

Scientific base for civil engineering

Not a "surrender" to science but rather the establishment of a more appropriate balance between the art of engineering and the scientific base on which new developments are built was the argument of a comprehensive paper[3] stressing the increased application by civil engineers of a wide range of scientific principles in problems involving: thermal phenomena, sonic methods, electrical and electronic test or control equipment, optical instrumentation, atomic and nuclear relationships, earth sciences, life sciences, and chemical reactions.

Greater initiative on the part of civil engineers directly in the imaginative use of scientific developments was urged as preferable to a belated "me too" attitude.

Engineering sciences

The emphasis on an integrated sequence in analysis, synthesis, and design was cited[4] as comprising the differentiating characteristic of engineering education. For an engineer the need is to constantly evaluate science as to its utility in achieving a design goal. Thus the whole interest of engineering education in basic science, it was pointed out, should be as a means of strengthening the engineering sciences and relating these more fully to the design concepts in engineering curricula. The overall objective therefore is to make more complete use of the scientific and mathematical background afforded us.

An interchangeable core

A notable contribution was the identification in a new light of what was termed the "interchangeable core"[5] and the clarification of the relationships of this core to the rest of the curriculum. Basically this core concept (Fig. 1) is intended to consist of much of what we already have in mathematics, basic science, the humanities, graphics and the engineering sciences. It would comprise approximately three-quarters of the normal four-year baccalaureate program and would be the foundation of the applied science and design courses of the upper years. The elements of this core would be taught chiefly, but not exclusively, in the first three years.

As the recommended content is examined it is easily recognizable; in fact, much of it is already in civil engineering curricula. What then was the significance of further discussion at this conference? Two interlocking suggestions stand out:

1. No part of the interchangeable core should be taught as terminal. The depth to which a student is required to delve into each subject should be recognized as dependent upon the attitudes and standards of the instructors and the retention of the material as dependent on the extent to which recall and use is demanded in subsequent courses. The misguided concept of "service" type courses of the past is totally unacceptable for components of an effective interchangeable core.

2. Highly qualified teachers who can strongly motivate their students are required in both the humanistic-social and the technological aspects of the interchangeable core. Such instructors must be well prepared to: (1) establish foundations, and (2) propound accepted dogma; but more important they must be prepared to (3) lead their students into fruitful excursions based on, but not restricted by, such foundations and dogma.

Finding and putting outstanding minds to work teaching these subjects is indeed a crucial problem. Convincing present faculties to accept new concepts will be one of the greatest challenges. Changing the framework of curricula will be essential also but changing the content of courses and altering teaching methods may be even more important.

Building on the core

Building on the interchangeable core[6] will require primarily the introduction of a sequence in the philosophy of design, wherein analysis, synthesis, and detail design develop the powers of engineering judgment and discretion. Without such a sequence, the curriculum is no longer engineering.

There will probably be an opportunity also for some branch electives, that is, structures, soils, transportation, sanitary; and for some functional electives, that is, research, production, construction, management. This type of elective curriculum may well lead to the award of a civil engineering degree at the graduate or professional-school level without the student having had course work in each and every one of the branches of civil engineering as now predominates.

The issue is whether or not it is necessary for all students to be generalists, in the broadest sense of the word, before becoming specialists. Can we not give the man who knows what he wants a chance to get right at it? The choice, it was pointed out, must be made between:

1. A program that provides an introduction to *all* principal areas within civil engineering, with the chance that future needs will change these or add new ones, and

2. A program that makes possible greater technical competence by permitting more depth in *several selected* areas.

Such choice need not be limited by conformance with present accreditation rules nor by existing state registration requirements. It is the right and the responsibility of ASCE members to share in the shaping of these criteria, so that they will never be unduly restrictive.

Professional curricula

At several points[7,10] the need was accentuated for the development of professional curricula over and above the equivalent of the present four-year curricula, that is, at the post-baccalaureate level, and under the administration of colleges of engineering.

It was proposed that "recognition be given to the need of providing two distinctly different types of advanced study programs, the one designed to meet the needs of the research-oriented student, the other to meet the needs of the practitioner-minded stu-

dent. Whereas the need for the first type of program is being met by the traditional type of program now in existence and leading to the M.S. and Ph.D. degree, the need for the second type has been almost neglected."

Rebirth of the degree, "Civil Engineer"

At this conference it became increasingly apparent that the degree of "Civil Engineer" needs to be reinstituted on a broader scale than at present used, and reserved for the recognition of accomplishment in high-level, resident, academic work.

The latest reported survey, made in 1953 by the Recognition Committee of ECPD, indicated a rapidly declining interest in the Engineer degree as a non-resident, non-academic recognition for achievement in professional practice. Accomplishment in professional practice is probably more appropriately recognized by advancement of the individual in membership grades of the ASCE, by professional licensure, and by election to academies of the type recently instituted by the sanitary engineering inter-society board.

It may well be that we are at the point in the development of the profession where the degree of Civil Engineer should be reborn as a recognized, accredited degree used only for graduate-professional residence study.

On-the-job training of graduates

Many points raised in the papers and discussions of this conference highlight the need of education for support from present practitioners in developing a more solidly based learned profession. In the forefront of these needs is greater utilization of the technological talents of the young graduate in the period of his early job assignments while he is still developing a greater sense of perspective and of judgment in actual practice.

Paralleling this need for more appropriate utilization of manpower is the need for supplementary training of young graduates through "industry"-sponsored courses.[8] The term "industry" when used in its broadest sense can well be applied to identify such branches of civil engineering activity as the construction industry, the railroad industry, etc.

Such training activities might well be in campus-conducted courses in selected institutions, but need not be degree credit courses. It will assist the regular degree programs immeasurably if a move can be made away from the concept that every campus course automatically earns academic credit and that every course must give credit toward some advanced degree.

A natural observation made by a number of conferees was that civil engineering departments by themselves could not follow the guide lines of the Theme Resolution without the concurrence of other engineering departments. Surely ASME, AIEE, AIChE, and AIME must be encouraged to consider similar action. Such encouragement is, in fact, one of the purposes of the Resolution. Indications are that there is much interest in these same educational objectives on the part of the other Founder Societies.

The best way to encourage the other segments of the profession to give attention to these same matters would be to take some positive preliminary steps in ASCE.[9] That this final goal may take time to achieve is all the more reason to take some action immediately. In this same connection the carefully worded introductory phrase of the Planning Committee Resolution, which stated, "Resolved that this committee *favors the growth* in colleges and universities. . . ." is intended to connote an evolutionary rather than a revolutionary process. Nevertheless it should be expected that while the action would be progressive and not precipitous, it would proceed along well-considered and predetermined lines.

Some of the conferees indicated that they were confused. They must be respected for such a frank statement of their position, for it was an honest indication of the fact that the problems before us are indeed perplexing ones. It does seem pertinent to point out, however, that the confusion appeared not so much in regard to ultimate aims and objectives as to the question of how far and how quickly we need to proceed at this time.

How far and how soon?

In other words, the difference in opinion appeared mostly to be on the question of how high the sights can be raised at this time—on the question of how far it is possible now to look over the apparent horizon. This is really a question of the distinction between long-range and short-range objectives. Obviously the results of this conference should embody some of each.

It would seem that there was unanimous approval of the objective of raising the quality of instruction in the present four-year program wherever it may exist and for as long as it may exist. Evidently there is unanimous support also in favor of expanding graduate-professional study.

Likewise members of the profession seem agreed that there is a need for a better product than that being produced by the present four-year program—but few want to give up the present program until they are more certain that there will be a significantly better product from an extended program. Obviously the need for the better educated professional man exists—and he is needed in substantial numbers. Perhaps the answer is that a few schools must lead the way with more complete educational experiments than others. The eminently successful ones will be imitated.

By this time the reader may be thinking that all of this has been said before. That may be true, but it is also true that what was said at this conference was never before said so completely by so many representatives of civil engineering education.

Apparently the major question is not, "Do we have a good program in civil engineering education?" But rather, "Do we have the best possible program?"

This conference in itself has not answered all the questions on civil engineering education but it may well have established the pattern on which more detailed discussions can now concentrate.

Balloting on the various resolutions adopted at the conference for further consideration will be conducted later in the year under a plan now being established by the Education Committee of ASCE.

Copies of the complete proceedings of the conference will be mailed in early 1961 to all accredited engineering schools and to all conference registrants under the terms of the National Science Foundation grant to Cooper Union. Additional copies will be available at that time from ASCE Headquarters at the nominal charge of one dollar.

REFERENCES

[1] Keynote address, N. M. Newmark

[2] The Scope of Civil Engineering, J. B. Wilbur; discussion, John Logan

[3] The Scientific Base for Civil Engineering, J. L. Waling; discussion, J. S. McNown

[4] The Distinction Between Engineering and Science, J. W. Graham and T. E. Stelson; discussion, M. P. White

[5] The Interchangeable Core, H. Gray; discussion, P. F. Chenea

[6] Building on the Interchangeable Core, H. D. Eberhart; discussion, E. H. Gaylord, Jr.

[7] Post Fifth-Year Education, R. E. Fadum (CIVIL ENGINEERING, August 1960, p. 80); discussion, V. L. Streeter

[8] Professional Education During Employment, J. W. Hubler; discussion, Mason Lockwood

[9] Impact on the Profession, F. Edwards; discussion, Fred Merryfield

[10] Long-Range Goals in Civil Engineering Education, J. E. McKee; discussion, D. H. Pletta

[11] Summary of Conference, C. Wandmacher

Recharge wells and pit underpinning

overcome column settlement caused by desiccation

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Serious settlement of buildings caused by desiccation, or drying out, of supporting soil is a common problem in the Southwest. But it was a surprise to Spencer, White & Prentis when this problem turned up in a large Baltimore industrial plant. The usual cause of such desiccation is climatic conditions. In Baltimore, however, the cause was artificial. A clue to this cause was the fact that only four columns out of the hundreds in the building had settled.

The 20-year-old building is supported by spread footings placed on hard red clay which had been assigned a bearing value of 6,000 psf. The layout of the four columns is shown in Fig. 1. In mid-December of 1959 these columns, which had gradually settled some 3 in. over a period of seven years, began to settle at the rate of ⅛ in. per week. This alarming settlement and attendant cracking of structural members prompted the owner to call on Spencer, White & Prentis to investigate the cause and perform the necessary remedial work.

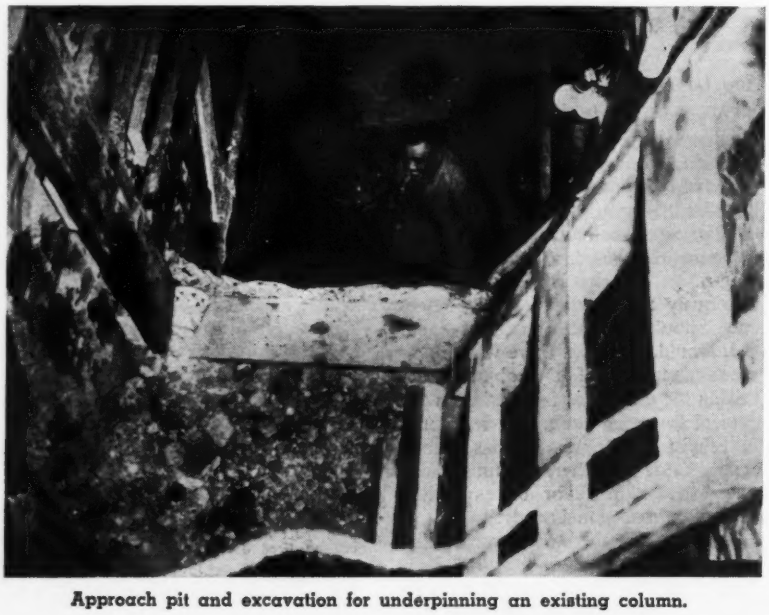
An exploratory program showed that the soil contained numerous fissures ranging in width from hairline to 1½ in., and narrowing in width with increasing depth. It was found that the extent of the desiccation varied considerably and that the soil had shrunk ¼ in. to ½ in. below the footings. Thus the four columns were being supported by the superstructure. Samples tested for moisture content showed 12 percent at the footing level and 21 percent at a depth of 12 ft. The change in moisture content was clearly seen in the exposed walls of the test pit, as the color of the clay went from a light brown to a deep red. A photo shows typical fissures and the change in color.

The cause of desiccation was found to be an adjacent hot-air heater unit, which had been drying out the soil to progressively deeper levels over the years. The desiccation was accelerated when settlement caused a concrete under-floor duct to crack, allowing dry air to circulate through the fissures. This forced circulation of dry air was observed in the test pit 16 ft away from the duct.

In determining the remedial work required, two criteria had to be met: (1) the load had to be transferred to a point below the present zone of desiccation, and (2) future desiccation to deeper levels had to be prevented. The first criteria was met by using concrete pit underpinning, which was founded on undisturbed soil 18 ft below the basement floor.

The expense of the extensive changes that would be required in the heater unit to meet the second criteria was prohibitive. It was reasoned that the drying-out process could be prevented from extending to greater depths and wider areas if the clay could be kept constantly wet. Therefore an automatic recharge system made up of five wells was designed; this maintains the water table at a constant level of 7 ft below the basement floor. A typical well installation (Fig. 2) consists of a porous gravel fill which extends the full height of the underpinning and is kept saturated by a porous pipe-well fed from the plant water supply. The water level is controlled by a simple float valve.

The underpinning was installed by the usual methods. After an approach pit had been dug to a depth 4 ft below the bottom of the footing, workmen tunneled horizontally under the footing. The remainder of the pit was sunk directly beneath the footing, to



Approach pit and excavation for underpinning an existing column.

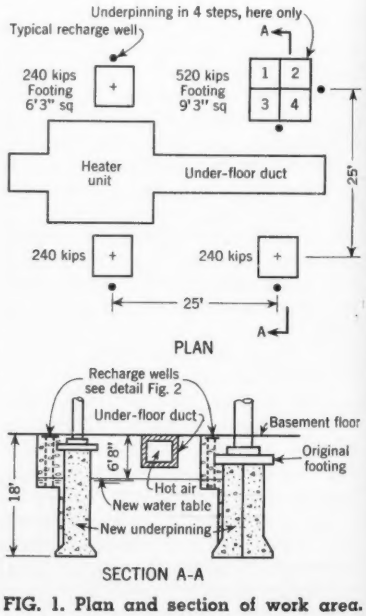


FIG. 1. Plan and section of work area.

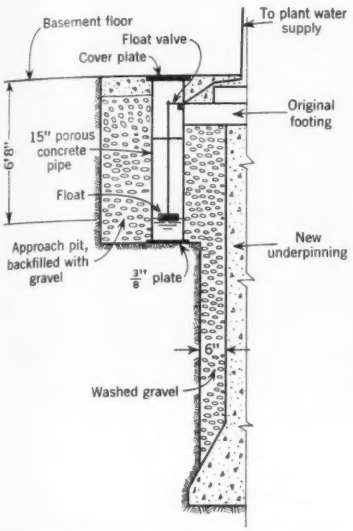
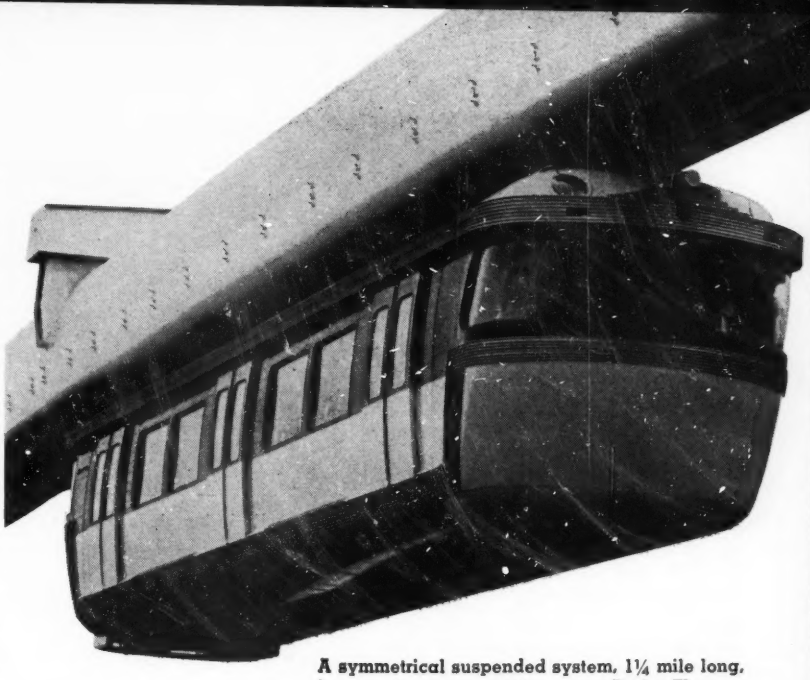


FIG. 2. Section through an underpinned column shows a recharge well.

18 ft below the surface, and belled out to the size of the original footing. For the three smaller columns, steel "needle" beams were fastened to the column and wedged to transfer the load to the adjacent soil. After the new concrete had cured for 24 hours, the pits were dry-packed; 48 hours later the needle beams could be removed. The underpinning for the remaining larger column was installed in four separate pits. By digging and concreting the pits one at a time it was unnecessary to use needle beams under the column.

Typical fissures in dried-out clay. Note difference in color in lower area where the moisture is higher.



A symmetrical suspended system, 1¼ mile long, is now in test operation near Paris. The car is suspended between two wheels operating within a circular girder with a split lower flange.

HIGH-SPEED MASS TRANSPORT

by an overhead system

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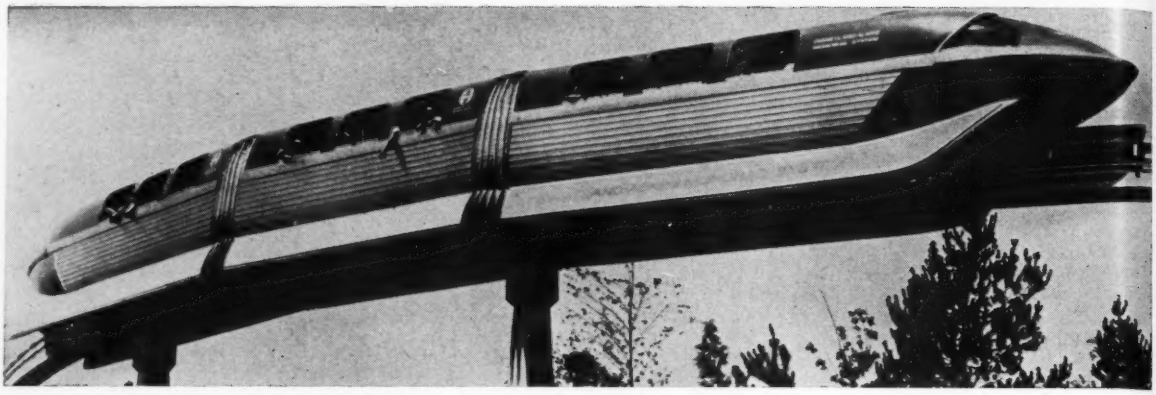
It is obvious that metropolitan centers of 500,000 population and over are dependent on some form of mass transportation. As we know them today, such centers cannot exist without it. With the surface avenues of traffic already congested and underground avenues too costly to contemplate, except perhaps in the central business district, the space above the surface provides a logical medium in which to operate. It is in this medium that an overhead high-speed mass transit system can be effectively employed.

The origin and first proponent of the overhead system of rapid mass transit on a single rail are difficult to establish, but the theory was undoubtedly devised well over a hundred years ago. The reason for its conception is attributable to a desire to improve the hard-riding and lateral oscillation of the railroad coaches and tramway cars of those early days. However with the technical knowledge available at that time, the lateral oscillation of an overhead system was also considerable, and a high speed was impossible. Technical advances since that time have now made it possible for such railroads to operate at high speed with perfect comfort to the rider.

The early advocates of the single-rail overhead system reasoned that concentration of the entire load on one rail would reduce lateral oscillation and thus permit a higher speed. Some of these overhead systems were called monorails, and most operated on one rail. However, the loss of lateral stability was so great that additional means had to be found to resist lateral forces due to wind and centrifugal forces. In general, these overhead systems can be classified in two categories—the over-running and the suspended type, with subdivisions within each category.

Over-running monorail systems

The over-running type, of which there are numerous examples, consists of five basic systems: the Lartigue



Disneyland's modified Alweg installation, about a mile in length, is in continuous revenue operation. It has proved to be a popular attraction.

monorail, the Brennan "gyroscopic" monorail, the Kearney "under-over" rail, the Alweg monorail, and the overhead high-speed mass transportation system recommended for Caracas.

The many other over-running systems proposed are variations of these basic systems.

The Lartigue system (Fig. 1) was developed by a French engineer, C.F.M.T. Lartigue, who displayed it at the Rouen Agricultural Exhibition in 1833. The single steel rail was supported by a low triangular trestle framework, with guide rails placed on each side of the trestle to prevent overturning. The cars were hung pannier-fashion, one on each side, from the vertical wheels. For satisfactory operation, it was essential to load the cars carefully so as to obtain an approximate balance between the two sides. The only real application of this system was a 9½-mile line installed between Listowel and Ballybunion in Ireland, inaugurated in March 1883. Although capable of operating at speeds up to 27 mph, the service speed was limited to 18 mph—certainly not a satisfactory rate by today's standards. It ceased operation in 1924, when a more modern transportation system replaced it.

The Brennan system (Fig. 2) was invented after 7 years of experimentation by Louis Brennan, an Irish engineer, who applied for his first patent in 1903. A large-scale model exhibited to the Royal Society in London was a true monorail in that it operated over a single 70-lb steel rail laid at ground level. The car was kept in balance by two gyroscopic wheels, each 3 ft 6 in. in diameter and weighing 1,500 lb, rotating in opposite directions at 3,000 rpm. While the system operated satisfactorily, its use was restricted because of a reluctance to accept a design in which the vertical stability depended on the continuous operation of gyroscopes.

The Kearney system (Fig. 3) was somewhat similar to the Brennan system in that it operated on a single steel rail below the car. However, vertical stability was maintained by introducing a second rail supported on standards above the car. As a matter of fact, this might be considered a conventional system with the tracks in a vertical rather than in a horizontal plane. Despite the use of two rails, this system is still classified as a monorail. It was publicly presented by its inventor, E.W.C. Kearney, in June 1908. It was designed to operate at elevated or ground level.

The Alweg system (Fig. 4) is contemporary in design. A full-scale test installation slightly more than one mile in length was completed early in 1957 near Cologne, Germany. It consists of a reinforced-concrete running rail almost rectangular in shape, and wide enough to permit two adjacent rubber-tired wheels to run on top. The rail is approximately 5 ft deep with supports every 100 ft. The depth can be decreased somewhat by reducing the length between the supporting columns. Installed on the sides of the running rail, at both top and bottom, are sets of rubber-tired wheels which act as couples to maintain vertical stability and resist horizontal wind forces or centrifugal forces on curves.

The cars of the Alweg system have two bogies located longitudinally in approximately the same positions as in conventional cars, and the driving wheels are located at the top of the running rails. The switching arrangement in the Alweg system requires that a segment of the entire running rail be moved from one position to another.

The introduction of rubber tires of high load capacity has brought forward a host of designs for similar systems.

A modified Alweg installation, approximately one mile in length, was completed in June 1959 at Disneyland in Anaheim, Calif., and has been in continuous revenue operation since that date. It has been very well received by the public and has proved a popular attraction there.

The overhead, high-speed, mass transportation system (Fig. 5) recommended for the Federal District of

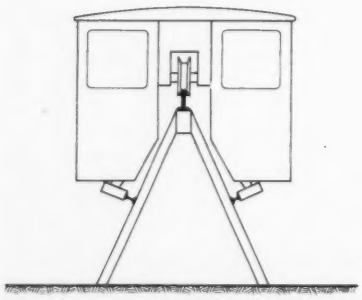


FIG. 1. In Lartigue overrunning system, displayed at Rouen Agricultural Exhibition in 1833, the single steel rail was supported by a low triangular trestle.

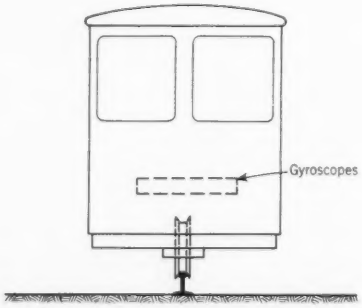


FIG. 2. Another overrunning type, the Brennan system, had restricted use because its stability depended on the continuous operation of gyroscopes.

Caracas was developed after many years of research in the Bingham organization. The objectives were to design a car light in weight, with a conventional floor and seating arrangement allowing free flow of passengers, which would be operated at high speeds, and to obtain a flexibility in switching movements comparable to that of conventional rapid transit systems. A unique track beam was designed to permit the operation of rubber-tired wheels on the lower flange and a horizontal stabilizer and guiding wheels above the traction wheels on a vertical section of the track beam. To obtain flexibility in switching, standard steel wheels were attached which rotate with the rubber-tired traction wheels. At the approach to a switch or crossover, standard rails were specified at an elevation that would relieve the rubber-tired traction wheels of the traction. Traction is then assumed by the standard steel rails, which can negotiate standard switches, crossovers and diamonds. This system thus combines the advantages of the monorail with those of conventional systems.

One of the most important features of this and other rubber-tired systems is that the train can readily negotiate grades up to 10 percent because of the greater traction of rubber-tired wheels on concrete as compared to steel wheels on steel rails.

Suspended monorail systems

Suspended monorail systems are subdivided into two categories, the symmetric and the asymmetric suspended systems. Both are further subdivided into many adaptations of the principles involved. The characteristic that differentiates them from the overrunning systems is that the car is suspended from the bogie, or truck, by an attachment to the roof instead of being supported on the bogie, or truck, by an attachment below the floor of the car. The large number of systems in each group differ only with respect to the type of bogie support or the attachment to the car, and the structures vary to accommodate these differences. Most of these systems are in various stages of development and have had little or no actual operating experience, with the exception of three to be described here.

A symmetrical system designed by French engineers, approximately a mile and a quarter in length, has recently been completed near Paris and is at present in test operation. The car is suspended between two wheels operating within a circular girder with a split lower flange. The bogies are equipped with pneumatic tires, horizontal guide wheels, and hydraulic sway-control devices. Switching is accomplished by a semi-turntable arrangement. Insufficient data are available to make a complete evaluation of its value for a rapid transit system.

In the asymmetric suspended system, the load of the car is transmitted to the traction wheels by means of a lateral arm attached to the top of the car, which then curves around the rail support and is attached to the upper side of the bogie. The first installation with this type of suspension was developed by Eugen Langen, of Cologne, Germany. It was installed in 1901 in the Wupper Valley between Oberbarmen and Vohwinkel for a distance of 2.8 miles, and in 1903 was extended to 8.2 miles. It is still in operation today; although cumbersome and slow, it has an excellent safety record.

Its speed of 18 mph was considered satisfactory at the time of its construction. Today, however, it cannot be recommended as a modern rapid transit system for metropolitan areas that are seeking solutions competitive on a speed basis with the modern automobile, and at the same time safe, comfortable and esthetically pleasing in appearance.

A modern development of the asymmetric design, originally constructed and operated for tests in Houston, Tex., was moved to Dallas, Tex., where it was in daily operation at the Fair Grounds for approximately three years. The structure, reflecting advances in materials and technology, has esthetic values that were not attainable by the early pioneers. The car also has benefited by the availability of modern lightweight materials and the use of rubber-tired wheels.

Comparison with conventional subway

A proper comparison between an overhead high-speed mass-transit system and the conventional subway, to determine which would be feasible and desirable for a modern metropolitan area, requires a consideration of many factors, some of which will be discussed.

In locations where the system could be underground, at ground level, or in open cut, the following factors must be considered: (1) cost of construction, (2) noise level, (3) speed, and (4) maintenance cost. For a viaduct structure, an additional factor, obstruction of light and air, would have to be considered.

1. Costs of construction vary considerably, not only from country to country and city to city, but even within the same city. The contour of the area, the type of soil, the subsurface installations that may be encountered, and the availability of nu-

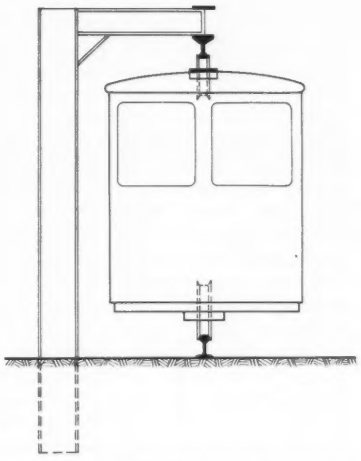


FIG. 3. Kearney overrunning system, with lower rail similar to that in Brennan system, had second rail above to provide vertical stability.

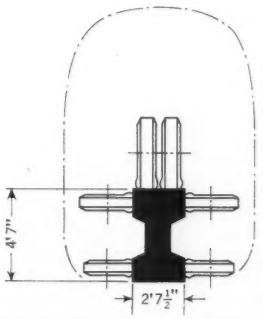


FIG. 4. Contemporary in design is Alweg system, a modified version of which was put in operation in Disneyland in 1959. Two rubber-tired wheels run on top of the reinforced-concrete running rail. At sides of this rail, at both top and bottom, auxiliary rubber-tired wheels run to maintain stability.

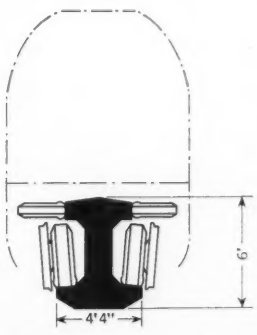


FIG. 5. In Bingham system, designed for overhead, high-speed mass transportation, rubber-tired wheels run along track beam (shown in black) in positions shown. At the approach to a switch, steel wheels shown on outside take over and operate like conventional wheels on steel switching track.

merous essential materials all combine to make it impossible to present definite cost figures without careful study. Location of routes may impose great difficulties for proper vertical and horizontal alignments and may require acquisition of valuable property easements. Underpinning of important structures, power supply and many auxiliary structures may also significantly contribute to construction costs. However, on a comparative basis it is possible to estimate the relative cost within any area.

Where the structure is built underground, as it should be in the central business district, or where it is built at ground level, the cost of construction of a new high-speed system should be the same as that of a conventional subway system. Above ground, or on a viaduct structure, the overhead high-speed system would be decidedly lower in cost.

2. The noise level in the operation of most conventional subways is so high that it has been considered a serious objection and has been a subject of study for many years. The noise of operation within an enclosure such as a subway is naturally much greater than when the same operation is in the open. The concrete enclosure acts as a sounding board, the noise being reflected from walls and ceilings, thus increasing its volume. Numerous methods have been devised in an attempt to abate the noise level, each with some effect.

Among the many methods used are rail welding, sound absorbing panels, rubber inserts in motors, the lining of walls and ceiling with sound absorbing material, and the use of rubber-tired wheels operating on wood rails. Not more than one or two of these methods have been employed in any system; therefore no accurate judgment can be made of the result of several noise abatement devices acting together.

3. Speed has frequently been used as an argument for one system as against another. These arguments invariably used the average speed of existing conventional subway systems, which vary between 17 and 25 mph, depending to a great extent on local or express service, on the time of day, and on the number of passengers carried. In most of the systems used in the comparisons, the distance between stations is a half mile or less. The maximum speed these trains can attain is approximately 55 mph. With stations spaced at a half mile or less, the maximum speed is seldom attained as the sum of the distances for acceleration to the maximum speed and deceleration for the next station stop exceeds the distance between stations. If stations were located two miles apart, even with the existing maximum, the average speed could be greatly increased. But in congested areas, the distance between stations should not exceed a half mile. In suburban operation or in sparsely settled areas where some feeder lines are necessary to reach the stations or the park-and-ride areas, stations can be two miles or more apart.

The unloaded weight of cars in general use today ranges up to 50 tons for a 60-ft car. Unquestionably these car weights can be reduced considerably, and with cars of lighter weight, the same motors in operation today would be sufficient to provide a higher maximum speed. As a matter of fact, the controlling limit in the reduction of car weight is the ability to maintain stability against lateral forces.

Because of the much higher traction attained by rubber tires on concrete than by steel wheels on steel rails, higher speeds and faster acceleration and deceleration can be obtained with the former. The limiting factor would be the ability of the standing passenger to withstand the shock.

4. Maintenance and operating costs, while readily available for conventional subway systems, are not available for the overhead high-speed system as none but experimental installations are in existence. Therefore only general comparisons can be made. Detailed studies of shop requirements for maintenance of operating equipment and track and structure for the overhead system indicate a substantial reduction in costs for the overhead system as compared to the high costs of maintenance for conventional subway systems.

Obstruction of light and air

More mileage of conventional mass rapid transit is operated on massive viaduct or elevated structures throughout the world than by any other method and this arrangement is regarded as the most objectionable. This type of operation is noisy and depresses real estate values. Most important, it obstructs light and air from adjacent buildings.

The conventional rapid transit viaduct structure without doubt can be improved architecturally and still meet the requirements for the support of heavy rolling stock. However, the new overhead high-speed system, by its very nature, lends itself to a more esthetic architectural treatment and thus greatly reduces air and light obstruction.

The median strip on a modern highway is an ideal location for an overhead high-speed rapid mass-transit line outside the congested area of a city.

The ideal mass rapid-transit system for a large metropolitan area is one that would operate underground in congested areas with stations located within walking distance of large concentrations of passengers. In areas where the population density does not warrant the cost involved in subway construction, the system should be located either in the median strip or on the side of a limited-access road, with stations not less than one mile apart. It should be a safe, high-speed operation with an unobjectionable noise level and attractive, comfortable cars. Parking areas should be provided at stations in the suburbs for passengers who live at a considerable distance and who "park-and-ride," as well as bus berths for feeder lines.

The fare structure should be competitive and reasonable enough to attract the largest number of passengers. The costs of construction, rolling stock and equipment for a conventional rapid-transit line adequate to meet the needs of a large community, together with cost of operation, have reached such large proportions that it is impossible to operate it at a realistic and competitive fare and at the same time meet both the construction and the operating costs.

Funds for the cost of construction and equipment should be provided by either a federal, state, city or county agency, and the cost of operation alone should be used as the basis for the fare structure. With tax exemption, efficient management and the use of technological improvements, I believe the operation could produce sufficient revenue at a reasonable fare.

What is needed is a Federal Department of Transportation that would be responsible for developing and administering a national transportation policy covering all forms of interstate transportation. This will bring together under one executive agency all the activities of the Federal Government concerned with the development of the best physical transportation plant and its use in an integrated system for the greatest benefit to the entire national economy regardless of the type of vehicle used.

Regulation of all forms of transportation should be vested in a regulatory agency that would develop and implement a regulatory program based on the maintenance of fair competitive standards for all. Whether this regulatory body should be within the framework of the proposed Department of Transportation or should be an independent agency, responsible to the United States Congress, is an open question.

Magnetic-flux welding yields savings

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R. J. FRICK, Assistant Region Manager, Electric Welding Department, Linde Company, Los Angeles, Calif.

In welding stiffeners for girders used in bridges on the Bayshore Freeway, San Francisco, Calif., a direct cost saving of 40 percent was achieved. This was done by substituting flux- and CO_2-shielded welding for manual welding with E-6024 coated electrodes. The fabricator, Kaiser Steel Corporation, Los Angeles, Calif., reports that stiffener welding makes up about 12 percent of the total man-hour cost in the 2½ million lin ft of welding on the job.

The welding process had to meet the following criteria:

1. Welds must be of uniform appearance, and free of undercut, porosity or structural discontinuities. The weld or heat-affected zone must have a maximum hardness of 175 Brinell.
2. A rigidly mounted torch is preferred to any mechanical guiding arrangement, because of good fit-up between parts and the need to weld the full length of the stiffeners.
3. Equipment must be compact and portable, to minimize both set-up time on each stiffener and movement from one girder to another.

The gas-shielded welding process was selected for the following reasons:

1. More accurate operator-guiding control of the rigidly mounted torch can be maintained with an open-arc process.
2. Gas-shielded processes require no flux-recovery equipment, as do submerged-arc processes, and are therefore more portable.

Kaiser chose Unionarc (Linde Co., Division of Union Carbide) welding from among the gas-shielded processes because of its superior weld quality. Because of the nature of the base metal and the lack of pre-weld cleaning (which is not economically feasible), it was felt that the gas shield alone, such as CO_2, would not provide welds of suitable quality. However, the magnetic-flux, CO_2-shielded process is tolerant to rust and mill scale, because of deoxidizers in the flux. Unionarc composition also refines the weld puddle, lowers the cooling rate, and contributes to desirable weld contour. Both flux and carbon dioxide gas shield the weld from contamination.

For simplicity of operation and maintenance, as well as for reduced bulk, two welding machines were used, one for welding each side of the stiffener. To approach or duplicate the previous operating factor for manual welding on stiffeners of approximately 50 percent, Kaiser designed a welding carriage for minimum set-up time.

A simple bridge crane, running along the flanges of the girder, serves as the track for the automatic welding carriage. "Flop-down" locators quickly position the machine for welding. Welding torch and adjustments are shaft-mounted, for fast, easy rotation into and out of place.

To obtain fully-automatic welding, the fabricator utilized a self-propelled welding carriage (with a current relay for automatic travel start and stop), plus an automatic control for constant wire-feed speed. Amperage and voltage controls are convenient to the operator. Wire-inch and retract controls operate without the wire being "hot."

Traveling at a speed of 25 in. per min, each welding machine deposits 19 lb of wire of ⅛-in. diameter per arc-hour, at 540 amp and 31 volts. The operating factor of 40 percent compares favorably with the previous manual welding factor of 50 percent. Because of the much faster welding speeds, the time saving achieved is 65 percent. Cost savings achieved amount to 5 percent of the total girder cost.

TABLE I. Cost of 100 ft of welding on stiffeners by two methods

WELDING METHOD	COST
Manual welding with E-6024 covered electrodes:	
Electrode, 20 lb per 100 ft @ $0.21 per lb	$ 4.20
Labor, hours (at 50-percent operating factor), 4.4 hr @ $2.72 per hr	11.97
Total direct cost	$16.17
Fully automatic Unionarc welding:	
Electrode, 12 lb per 100 ft @ $0.20 per lb	2.40
Unionarc flux (0.6 lb per lb of wire), 7.2 lb @ $0.384 per lb	2.76
CO_2 (at flow rate of 45 cu ft per hr), 28 cu ft @ $0.01 per cu ft	0.28
Labor hours (at 40-percent operating factor), 1.57 hr @ $2.72 per hr	4.27
Total direct cost	$ 9.71

Gas-shielded magnetic-flux welding equipment, adapted for fully automatic operation, is used to connect web stiffeners in a plate girder.

Price trends for building materials

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Prices of building material will continue to go up generally for the next five years, along with most commodities and the Gross National Product. The question of how far up the prices of building materials will go and at what rate for each of the years, is the subject of this discussion.

Most of the comments made here have to do with the approach and methods used in developing this projection. A projection of this kind is only as good as the analysis and data that go into it. Furthermore, if these comments are to be of greatest use under all conditions, it is important that appropriate changes be made to the projection in the event that unforeseen political and economic developments take place. It would be foolish indeed not to make any allowance for unexpected occurrences and developments. On the other hand, of course, these comments today must be based on an appraisal of the most probable course of events.

A few general observations about the nature of building material prices are in order. In projecting the price trend of building materials, considerable attention has been paid to the future course of total construction activity and changes in the Gross National Product (GNP). This would not be advisable if building materials were not so important in the country. A rise in the value of total construction, as well as in the value of all goods and services, has the effect of bringing about a smaller percentage rise in the price of building materials. This has been the case in the past and there is no reason for believing that it will not be so in the future, barring the imposition of price controls by the Federal Government in a time of national emergency.

The fact that building materials are used by other industries besides construction must be borne in mind when weighing the factors that affect future prices. In the main, the effect is a tempering one which keeps building material prices from fluctuating quite as much as if these commodities depended entirely on the construction industry. This effect is particularly apparent in comparing the composite price index of "All Building Materials" with the index of all commodities. These two indices have followed each other quite closely, except for the war years, for the past 44 years. It is therefore reasonable to believe that these two indices will move together over the next five years.

An important assumption is of course the political one that there will be no armed conflict anywhere in the world that will draw our country in. Only such a political catastrophe, and for that matter, economic catastrophe, could seriously disrupt the projections and disturb the balance of economic forces on which these projections are based.

Past performance of material prices

The first step in assessing the outlook for building material prices is to look at the past performance of these prices. (See Fig. 1.) This is useful for two reasons. The obvious reason is the tendency of the price trend line to extend itself at the same slope it has maintained in recent years. Only slightly less important is the knowledge of how the prices of particular building materials or a group of building materials have behaved. Some materials have moved relatively little in the past 44 years while others have moved widely. Still other price series have moved erratically with respect to "All Building Materials." Trends for this last category cannot be projected with as much assurance as those for the majority of building materials.

There are only a few building materials to choose from. Building material prices have been gathered in a comparable manner for a long period of years by the U.S. Bureau of Labor Statistics, which has carried back its price index of "All Building Materials" to 1915. Of the several individual commodities and commodity groups for which price indices are available, four have been chosen for study here because of their wide use in large volume—lumber, portland cement, structural steel shapes, and structural clay products.

Composite price index

The movement of the composite index of "All Building Materials" during the past 44 years has been characterized by four general phases:

1. Steep climb, 1915-1920
2. Postwar decline and partial recovery, 1920-1923
3. Decline, gathering momentum 1923-1932
4. Steady rise, with steepest movement right after Second World War, 1932-1959. Prices increased 3.6 times in 27 years.

It is significant that the five reversals of trend in the past 27 years were associated with contractions in the business cycle. However, all these reversals were rather small. See Fig. 2.

Hence, on the basis of the past 44 years there seems to be one basic conclusion—that unless total construction and Gross National Product move much more violently, either upwards or downwards, than they have done since 1951, the composite index of "All Building Materials" can be expected to move within a range of plus 5 percent and minus 1 percent for a given year over the next five years.

Lumber prices have fluctuated more widely than the price index for "All Building Materials" over the past 44 years. In particular, it is noteworthy that the price of lumber increased 6.5 times between 1932 and 1959 whereas "All Building Materials" rose only 3.6 times in the same 27 years. Furthermore, during the past nine years, the price of this building material has reversed its upward trend in five of those years.

There is little question that the price of lumber is volatile and behaves in an erratic manner. In view of this price history a price rise in a given year of 8 percent would not be surprising in the next five years, nor would a decline of 6 percent be out of the ordinary.

Portland cement prices moved less widely in the past 44 years than the index of "All Building Materials." For example, in the 10 years 1934-1944, the price of portland cement rose less than 3 percent and otherwise

varied very little from year to year. During the 27 years 1932-1959, the price index of the Bureau of Labor Statistics rose only 2.6 times, which is considerably less than the composite index for "All Building Materials." In this connection it is interesting to note that the price of cement has the distinction of not having declined in any year since 1943.

Under the circumstances it is to be expected that the price of portland cement will continue its rise over the next five years.

Structural steel shapes remained absolutely constant in price from 1939 to 1945, although it has been more characteristic of this material to swing widely in price in response to economic pressures. Thus on the one hand, on account of the "Great Depression" and the subsequent price controls, the price of structural steel shapes increased only 3.9 times in the past 27 years. This is only a shade more than the price rise of "All Building Materials." On the other hand, since 1947 the price of this material has more than doubled and surpassed the price rises of the other building materials considered in the same 12 years by a wide margin.

This price history seems to indicate a continuation of the rapid price rise for structural steel shapes unless a depression of the pre-war variety should strike in the next five years. This last is very unlikely.

Structural clay products remained moderate in their price movements throughout the 33 years for which data were available. The price of these products rose only 3.2 times since 1932, which is somewhat below the increase posted for "All Building Materials." While the rise has been only gradual, it is worth noting that, as in the case of portland cement, each year since 1943 has seen an increase in the price of this material.

With such a price history in the background, a continuation of the gradual price rise for structural clay products seems indicated for the next five years.

Influence of general economic trends

The question of the effect of business expansion or contraction on future prices of building materials is the second step in this discussion. By examining the effect of general economic trends on the price of building materials in the past, conclusions can be drawn about the future.

The effects of business expansions or contractions on the price of building materials will make themselves felt first through the construction industry. Mention has already been made of the relationship between construction and building material prices. For most of the 44 years considered, as the value of total construction rose, the price index for "All Building Materials" also rose but to a smaller degree. The fact that labor costs are included in the value of construction probably accounts for much of the difference in the movement of these two series. But for many of these 44 years the prices did not move even in the same direction as the value of construction. In other words, the correlation is apparently poor. Nevertheless, if labor costs do not rise very fast it is expected that the value of total construction will move in the same direction as the prices of building materials.

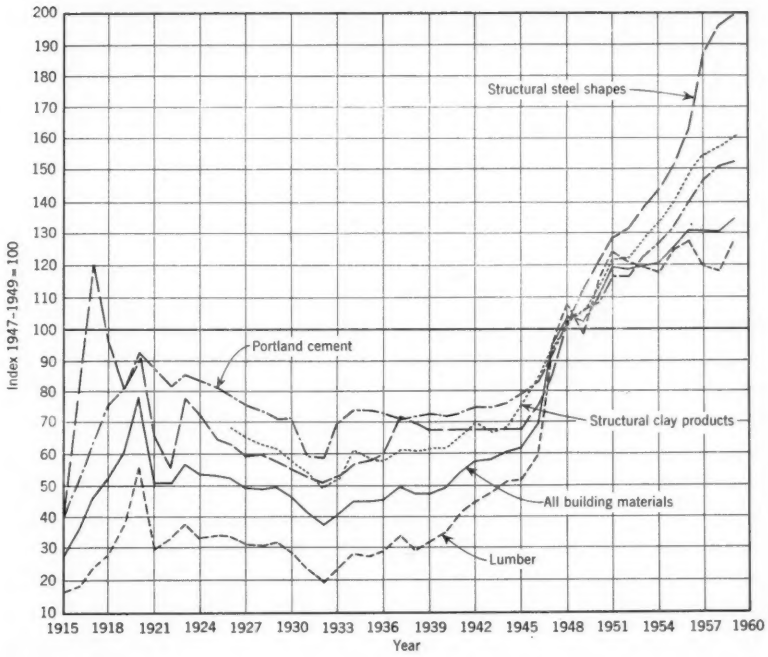

FIG. 1. Wholesale prices of building materials from 1915 to 1959, based on 1947-1949 = 100.

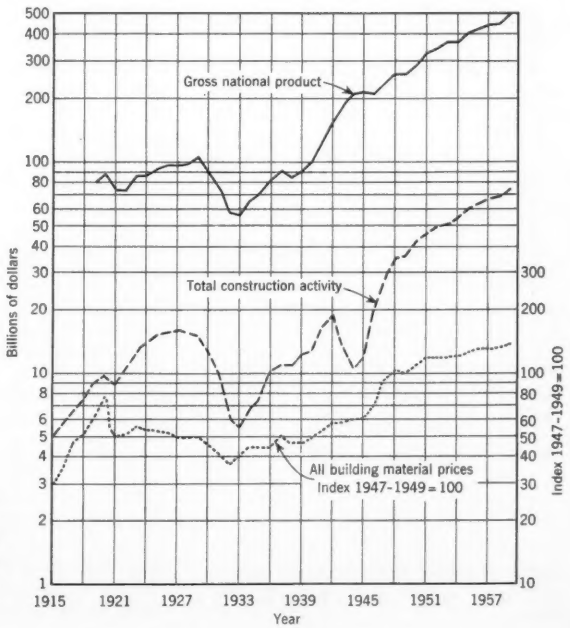

FIG. 2. Gross National Product and total construction activity plotted with the wholesale price of building materials.

A comparison between the movement of the price index of "All Building Materials" and the Gross National Product is clearly the best means of measuring the influence of general business conditions. While the GNP is in some respects more removed from the immediate factors influencing the prices of building materials than total construction, the prices of building materials are also influenced both on the demand side and on the supply side by other industries. It is of course true that not all the production of a building material enters the construction industry and that many materials used in construction are used to a greater extent in other industries.

The relationship between the Gross National Product and prices of building materials has been much closer over the past 30 years than has the value of total construction. Some reasons for this have already been mentioned. Another major difference may be the factor of wages in the total value of construction; this factor may be relatively smaller in the GNP. Moreover, the GNP has risen each year with only minor interruptions whereas the value of construction fell precipitously during World War II. Over a span of 30 years the GNP and the price index of "All Building Materials" moved in opposite directions only five times. On the two occasions during the 1930's the reason was the Government's recovery program, which did not affect the building material industries as much as the economy as a whole. Right after World War II the GNP fell at a time when building material prices rose. In the 1950's there were two instances of opposite movement. But the changes were small.

While the agreement between the value of all goods and services and the price index for "All Building Materials" is far from perfect, there is a strong probability that a rise in the one will be accompanied by a rise in the other. It appears reasonably safe to expect that this relationship will be maintained for the next five years.

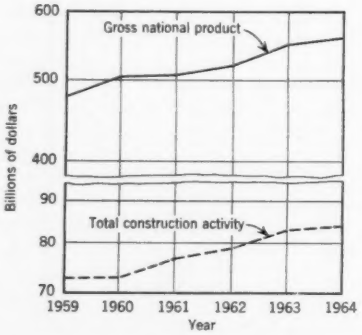

FIG. 3. Projected Gross National Product and Total Construction Activity, 1960-1964.

General trends projected

The third step in arriving at the price outlook for building materials involves two procedures. The first is to arrive at the outlook for general economic trends for the next five years. The second is to tie these general trends into the price behavior of the composite price index for "All Building Materials" and the price trends of the four individual building materials that are being considered here.

Up to this point the writer's comments and observations have not run serious risk of error or contradiction. At this stage of the presentation it is essential that both risks be taken. Errors in projection are part of the hazards of practicing economics. But the risks of contradicting others who have already expressed themselves elsewhere is due in part to the nature of this discussion. The projections of the GNP, construction activity, and building material prices are therefore based on a combination of fact and judgment.

Unquestionably a most important part of a five-year projection of building material prices is future business conditions as reflected in the GNP. In undertaking to develop a projection of the GNP it has been found advisable to divide it into two parts—a determination of its underlying, long-term rate of growth and the timing and amplitude of the next recession.

After reviewing several long-term projections of the GNP, which assumed an increase in the rate of productivity over the average prevailing since the turn of the century, the high rate of 4 percent per annum was selected as the most probable. It is recognized that there is probably a psychological element of hopefulness inherent in this figure. But in view of the enormous current expenditures on research and development now being planned there appears to be considerable justification for this choice.

On the heels of the recession of 1958 and the recovery of 1959, it is believed that the present business cycle reached its peak in the first half of 1960 and that the GNP will rise to a level of $504 billion for all 1960. The steel strike last year had a dampening effect on the economy and the long-term growth of inventories indicates a further rise in this item in 1960. It is believed that the normal growth of the economy will bring about the projected figure and that no great new surge of consumer buying will be necessary to add $22 billion to last year's GNP of $482 billion.

If the current business cycle has already reached its peak in 1960, it means that 1961 will see first a contraction and then an expansion in business activity. Following the experience of the post-war recessions, it is expected that the current recession will be a minor one. Interest rates are falling and mortgage money is becoming cheaper and easier to find. Federal, state and local governments will almost certainly step up expenditures if business should show more signs of weakening. Such action will have a stimulating effect on the economy. Hence the recession of 1960-1961 should be brief and mild. Moreover, the recovery will appear later in 1961. The GNP is projected at $508 billion in terms of 1960 prices, or $4 billion above 1960.

Complete recovery is anticipated in 1962, when the GNP should reach a new high of $520 billion. And 1963 should be a boom year, with the GNP reaching $550 billion. Instead of a decline in the GNP in 1964, only the rate of increase will decline appreciably and the GNP will go to $560 billion in terms of 1960 prices. See Fig. 3.

The next most important general measure that will certainly influence building material prices is total construction activity. Since 1950 it has moved more or less in unison with the Gross National Product. But it has fluctuated a little more than the GNP from one business cycle to the next. See Fig. 3. This pattern has therefore been incorporated in the following projection for the total construction activity:

Year	Billions of 1960 Dollars	Year	Billions of 1960 Dollars
1959	$73.0	1962	$79.0
1960	73.0	1963	83.0
1961	77.0	1964	84.0

The time has now come to put together the pieces of the jigsaw puzzle. It will be recalled that the pieces are made up of the price histories of four specific building materials and the composite price index; the relationship between total construction activity and Gross National Product on the one side and the index of All Building Materials on the other; and five-year projections of the GNP and total construction activity. The picture for the next five years emerges as Table I and Fig. 4.

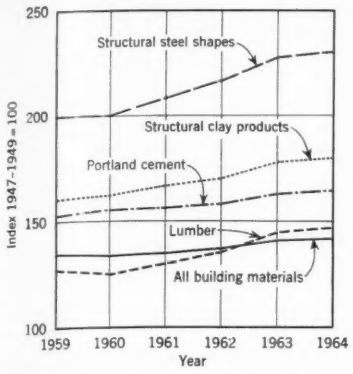

FIG. 4. Projected price indexes of selected building materials for 1960-1964 on the basis that 1947-1949 = 100.

TABLE I. Projection of building material price indexes
1947-1949 = 100

Year	All Bldg. Matrls.	Lumber	Portland Cement	Struct. Steel Shapes	Struct. Clay Products
1959	134.6	127.1	152.2	199.6	160.2
1960	134	125	155	200	162
1961	135	130	156	208	166
1962	137	135	158	216	170
1963	141	145	163	227	178
1964	142	147	164	230	180

This table of 30 figures may be briefly summarized for each building material:

"All Building Materials" will show a rise totaling about 5½ percent in the next five years. This includes a decline of less than 1 percent in 1960.

Lumber will rise about 15½ percent in the same interval, and will suffer a decline in 1960.

Portland cement, as in the past, will rise a bit each year but will show an increase of only about 8 percent by 1964.

Structural steel shapes will increase in price each year with the sharpest rise coming in 1963. The total rise in price for the five years will be a little over 15 percent.

Structural clay products, like the two preceding materials, will rise in price each year and the entire rise for the five years will be a little over 12 percent.

In closing it is desirable to emphasize the writer's concurrence with the belief generally held that inflation will continue throughout the next five years. The foregoing five projections of building material prices must be considered as five different aspects of the national economy in the throes of a prolonged inflationary cycle.

The forecasts made here are the ideas of the writer and may or may not be in line with the views of the organization with which he is affiliated.

THE READERS WRITE

Oppose legislation sought by pressure groups

TO THE EDITOR: As successive issues of engineering publications come to the engineer carrying news of legislation formulated by union representatives, this problem takes on a more and more serious aspect. The following appeared in "The High Spots" column of the *Consulting Engineer* for Oct. 1960, p. 143:

"Meanwhile, a recent attack on licensing boards by newspapers in the Los Angeles and San Francisco areas is said to be the opening of a drive by the union to seize control of the licensing function of government. Their first step would be to demand lay, i.e., union representation, on every one of the various licensing boards."

Reference is made to "Consulting Engineers Fight Secondary Boycotts," *Consulting Engineer*, October 1960, p. 74. This pertains to the Kennedy-Thompson bill. The writer concludes that if such legislation is passed, benefits from the Landrum-Griffin Act will be erased and secondary boycotts will become a reality. The implication is that the engineer will be forced into union membership if he is to fulfill his obligation to his clients—that is, to see a job through from design to completed construction.

It is evident that professional engineers do not wish to become unionized or to be forced to accept legislation conducive to unionization. Union strength is gathering momentum each year. Few areas are immune to this misguided strength, including local, state and federal governments.

To date we have been protected by the Taft-Hartley Act and the Landrum-Griffin Act. In the past 12 years, 33 pieces of legislation favoring labor have been introduced into Congress. How many pieces of legislation favoring the professional man have been introduced during this interim?

The situation leads me to conclude that professional representation is stagnating. As engineers we are willing to endorse legislation that favors the profession but we are reluctant to sponsor such legislation.

As a member of a professional society, I am but one of many who hope that these statements can be refuted. Whether refuted or confirmed, we as society members have not been adequately informed.

The engineer must take an active part in legislative matters. If his efforts are to be most effective, he must receive a personal notice of proposed legislation, a concise analysis of its contents, and a statement of what the effects will be if it becomes law. The facts are available to our representatives in Washington. The "power of the press" is available to the directors of our societies. The mails are available as a media for communication. We as engineers are available to receive the facts.

The engineer has a civic and professional responsibility to his government. With the facts in hand, we can, as individuals and as a united profession, approach our local, state and Congressional representatives. With their help we can introduce legislation that will be beneficial to all and deter legislation that is beneficial only to pressure groups.

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First cable-suspended circular-roof structure

TO THE EDITOR: You will be interested to know that students of engineering and architecture at Columbia University, New York, built a cable-suspended circular-roof structure at Camp Columbia before such a structure was built at San Antonio, Tex., as described by W. E. Simpson in CIVIL ENGINEERING for November 1960, p. 63. The Columbia University structure, known as the Bruno Funaro Pavilion, was designed as a joint project of the Schools of Engineering and Architecture at Columbia. It was built at Camp Columbia, Litchfield, Conn.

Twelve timber columns 13 ft high support a circular timber beam 48 ft in diameter. From this, 36 cables of ⅜-in. diameter connect to an inner ring of 4-ft diameter located 3 ft 9 in. below the outer ring. Precast concrete slabs, 250 of them, were placed on the cables and temporarily loaded with bricks before grouting.

This may have been the first such cable-supported structure in the United States rather than the Assembly Building at San Antonio. More complete information appears in the *Columbia Engineering Quarterly* for January 1958.

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A graphic solution for soil pressure under eccentrically loaded footings

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A simple graphic solution is available for finding the theoretical distribution of soil pressure under an eccentrically loaded rectangular footing. This method is based on the graphic solution of the problem of locating the centroid of a trapezoid whose height and bases are known.

Given the trapezoid shown in Fig. 1 (*a*) of height *h*, and bases *a* and *b*, lay off the lengths *a* and *b* on their opposite bases, locating the points (1) and (2). Draw a line connecting these points.

Next connect the center of each of the bases, *a* and *b*, with a line (3)-(4), as shown in Fig. 1 (*b*). Point (5), the intersection of lines (1)-(2) and (3)-(4), is the centroid of the trapezoid. The proof of this construction is a simple problem in geometry.

In applying this solution to the problem of determining footing pressures, the engineer knows the size of the footing and the magnitude and location of the resultant of the applied loads. In determining the soil pressure distribution, the process is to reverse the above graphic solution. Given the average ordinate and the location of the centroid of the trapezoid, the lengths of its bases can be found.

Dividing the applied load by the area of the footing, the average ordinate, *P/A*, of the trapezoid is determined. Laying this dimension off as shown in Fig. 2, a point (1) is established. Through this point the pressure-distribution line, which by theory is a straight line, must pass. The problem that remains is to determine the slope of this line.

To find this slope two trial approximations of known centroid will be made, and the resulting error plotted. The plot will be used to determine the point of zero error, thus establishing the slope.

As a first trial the line (0)-(1)-(2), shown in Fig. 3 (*a*), is assumed to represent the pressure distribution. This produces a triangle whose centroid is known to be at the third point. This third point may be located in the same fashion as the centroid of the trapezoid in the original solution, or merely measured directly. If the triangle were the correct distribution, its centroid and the load centroid would have coincided. However, generally they do not coincide, and the error is noted in Fig. 3 (*a*) to be e_1, to the right of the load centroid. This error is laid off to the right from point (2), as in Fig. 3 (*b*), establishing a point (3).

In a similar fashion the second approximation is chosen to be (0′)-(1)-(4), as shown in Fig. 4 (*a*). This establishes a second error, e_2, to the left of the load line. Laying this error off to the left from point (0′) establishes a point (5), shown in Fig. 4 (*b*). Drawing the line (3)-(5), a point *E* is established where line (3)-(5) crosses line (0′)-(2). This point *E*, where the "error" is zero, determines the length of the right base of the correct pressure trapezoid. Points *E* and (1) establish the slope of the line, giving the final soil pressure distribution to scale. The result is shown in Fig. 5.

A rigorous proof of this solution is not presented here as the only variation from normal procedure was the drawing of the line (3)-(5) to locate *E*. This construction is familiar to students of graphic analysis. The validity of the construction is evident.

Two facts are of additional interest. If the load centroid is outside the kern, the graphic solution will still satisfactorily indicate the tensile stresses predicted by statics. Point *E*, however, will not fall between points (0′) and (2). Second, the triangles were used only because their centroids were easily located. It is just as convenient to use the *P/A* line in Fig. 2, with its centroid at the midpoint of the footing. Any approximation is valid.

My experience in using this graphic procedure in practice is that it is reasonably fast, and often more convenient than the normal algebraic approach. Also, the resulting stress diagram is in a more usable, understandable form.

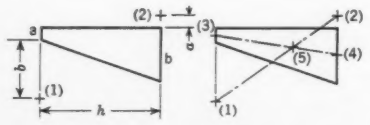


FIG. 1 (a) FIG. 1 (b)

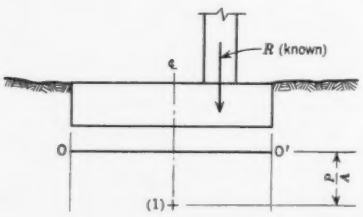


FIG. 2

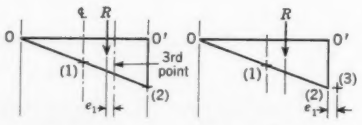


FIG. 3 (a) FIG. 3 (b)

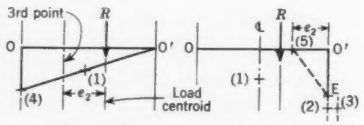


FIG. 4 (a) FIG. 4 (b)

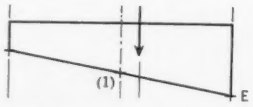


FIG. 5

ASCE Nominates Outstanding Projects

Eleven major engineering projects have been nominated in the competition to select the Outstanding Civil Engineering Achievement for the 1961 Award. The nominations were made by Directors of ASCE and will be judged by the editors of eight engineering magazines. Nominations were made only for truly outstanding projects, accounting for the fact that some Districts are not represented this year.

Judging will be based on three general categories: (1) engineering skill demonstrated; (2) evident engineering progress, and (3) value of the project to mankind. The award goes to the project rather than to individuals or groups connected with it. The 1960 Award, the first year of the competition, was given to the St. Lawrence Power and Seaway Development.

The nominations by District are as follows:

Idlewild International Airport—Idlewild Airport, nominated by District 1, is a unique complex, 4,900 acres in size and designed to handle nearly all the New York Metropolitan Area's international air traffic, half its domestic long-haul air traffic, and one-quarter of its domestic short-and-medium air traffic. By the end of 1960, a total of $233,000,000 had been spent on its construction by the Port of New York Authority, its operator. The civil engineering involved is of a magnitude unprecedented in the history of airport planning, design, and construction, and the airport has become known as the laboratory of aviation facilities for the Jet Age. The airport's Terminal City has a total of ten terminals. The runway and taxiway system now includes five runways and seven miles of taxiways.

Pan American World Airways Terminal Building, Idlewild International Airport—This $8,000,000 elliptical-shaped building is topped by an elliptical roof with a wide overhang. The framing combines elements of suspension-bridge design with those ordinarily used for buildings. The canopy projects 114 ft beyond the columns supporting the roof and provides shelter for several jet planes around the periphery of the glass-enclosed structure. The basic design was influenced to a great degree by the owner's wish (1) to provide permanent weather protection on the apron side for both passengers and the servicing of aircraft, and (2) his desire to contribute toward the convenience of passengers by eliminating long walkways and stairways. The terminal is a District 1 nomination.

The Chase Manhattan Bank—This building, another District 1 nomination, represents a new concept in building planning for New York's crowded financial district. The 60-story building stands in a 2½-acre open plaza, covering the greater part of two city blocks. Its facade is of glass and anodized aluminum. Total floor area is over 2,250,000 sq ft, with each floor above ground having an area of about 30,000 sq ft. Its frame required approximately 50,000 tons of steel.

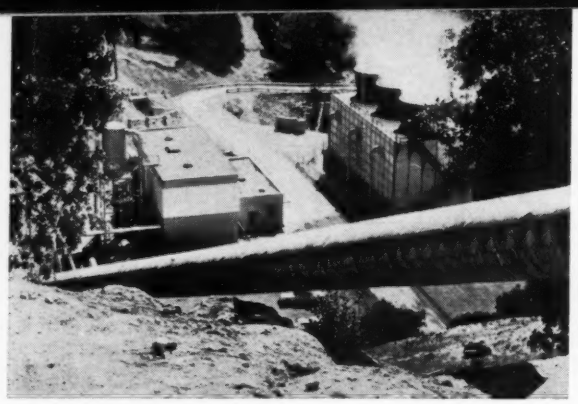
Intelex Postoffice Building—This Providence, R. I.. building, the choice of District 2, was constructed to house the world's first fully-mechanized postoffice. As modern as the mechanical and electronic equipment it houses is the spectacular building itself. To observers, the intersecting barrels of the thin-shell concrete roof, the large expanses of glass, and the clean lines of columns express function as well as beauty. Its roof area is about 3½ acres, with the entire area supported by only ten columns in the exterior walls and two interior columns. The roof consists of two longitudinal parabolic concrete barrels intersected by three transverse barrels. These form six units, each 140 ft by 150 ft.

Niagara Falls Power Development—Nominated by District 3.

Portage Lake Bridge, linking Houghton and Hancock, Mich.—This $11,000,000 lift bridge, which allows traffic to flow unimpeded into Portage Lake, is one of the heaviest lift bridges ever built. The bridge operates on three levels. When the lake is frozen, the lower position, 7 ft above the ice, carries railroad traffic, while automobile traffic is confined to the upper level. When the lake is open, the span is stationed at 32 ft to accommodate passage of small pleasure craft under it. The third position is at 135 ft to permit passage of the largest of the Great Lakes ships. The Portage Lake Bridge is the nomination of District 7.

Dresden Nuclear Power Station—The Dresden station in Chicago, choice of District 8, is the first full-

Pan-American World Airways Building, one of three projects nominated by District 1, is a glass-enclosed elliptical-shaped building that provides shelter for several jets around its periphery.



The Geysers Power Plant at Sonoma, Calif., is one of two projects nominated by District 11. The geothermal plant utilizes natural steam from deep underground to generate electricity.

scale, privately financed atomic power plant to come into service anywhere in the world. The 180,000-kw plant's nuclear power reactor is larger than any now in operation or under construction in the United States. The unusual structural features of the Dresden Station are the 190-ft-dia steel sphere designed to contain fission products in the remote chance of a serious accident and the 300-ft-high concrete stack through which the ventilating air circulated through the process buildings is discharged into the upper air strata. The station includes many forward steps in power-generating techniques which are pace setters for the atomic power age.

Hyperion Effluent Outfall—The Hyperion Effluent Outfall at El Segundo, Calif. is a reinforced concrete submarine pipeline, 12 ft in diameter, conveying the primary effluent from the Hyperion Sewage Treatment Plant to a special wye-structure located five miles offshore in Santa Monica Bay. At that point, the pipeline splits into two 4,000-ft-long diffuser legs, 8½-ft in diameter which reduce to 6-ft in diameter. Each leg has diffuser holes ranging from 6¾ to 8⅛ in. in diameter, spaced alternately on 48-ft centers along each side of the pipe. The entire diffuser section is in water approximately 194 ft deep. The wye structure permits passage of a cleaning device and is designed to permit extension of the pipeline. The Hyperion Outfall is the nomination of District 11.

The Geysers Power Plant—This pioneering project at Sonoma, Calif. —another District 11 nomination— uses natural steam from deep underground in an area of steam fumaroles called The Geysers. In the operation of the $2,000,000 geothermal power station, a pipeline collects the steam from the producing wells and carries it a quarter-mile to the generating plant. There the natural steam jets against turbine blades, producing electricity in essentially the same manner as if the steam had been produced in a boiler with gas or oil, or in a reactor with fissioning uranium. The plant has a capacity of 12,500 kw, and the turbine uses about 240,000 lb of steam per hour. The Geysers power plant points the way toward utilization of a vast, untapped source of power.

Lloyd Center—This shopping center, in Portland, Ore., is actually a city within a city, and probably can be regarded as a super shopping center. It was so designed from a civil engineering standpoint, and includes storm sewers, sanitary sewers, streets, curbs, sidewalks, parking lots, as well as the major structures and vehicle and pedestrian traffic control. The Center occupies over 40 acres of land in the metropolitan Portland area, about six minutes from the downtown district. The amount of electric power used annually at Lloyd Center would serve a city of 10,000 people. District 12 nominated Lloyd Center.

Grand Isle Sulphur Mine, Gulf of Mexico—The Grand Isle project, 7 miles offshore of Grand Island, La., mines brimstone deposit from 2,000 ft below the surface of the water. A $30,000,000 steel island, almost a half mile in length, it is built above an underground salt dome whose cap contains the world's third largest sulphur deposit. The offshore facilities are comparable to the essentials of an onshore mine. The power plant, living quarters, production platforms are set on permanent or semi-permanent steel-pile-supported platforms joined together with 200-ft-long bridge spans. (See CIVIL ENGINEERING, June 1960, p. 50.) The entire structure has been designed to withstand the worst hurricane winds and waves that have been predicted for the site, seawater corrosion, and effects of subsidence of the Gulf floor due to the removal of sulphur from the underlying ore body. District 15 nominated the Grand Isle Sulphur Mine.

Rules for Daniel W. Mead Prize Liberalized

Revised rules for the Daniel W. Mead Prizes were approved by the Board of Direction at its Boston meeting in October. The new liberalized rules supersede the directions for contestants published in the 1960 official Register. The forthcoming 1961 Register will list the revised rules.

One of the important changes is transfer of the responsibility for the prizes from the ASCE Committee on Professional Conduct to two committees of the Department of Conditions of Practice—the Committee on Student Chapters and the Committee on Younger Members.

In the 1961 competition, which is now open, Associate Members and students will write on any professional civil engineering subject, though preference will be given to outstanding papers on professional ethics. In the past contestants wrote on a set topic determined by the Committee on Professional Conduct.

The competition on which the final award is based is conducted in three phases:

1. Written papers must be presented before a Local Section meeting, a Local Section Conference, or a Student Chapter Conference.

2. Papers selected in the foregoing Section or Chapter meetings will be entered in a Zone contest conducted by the ASCE Vice Presidents.

3. The papers selected as Zone winners shall automatically be entered in the national contest conducted by the Committee on Conditions of Practice, the Student paper to be judged by the Committee on Student Chapters and the Associate Member papers to be judged by the Committee on Younger Members. A national winner will be selected in each category. The Associate Member Prize is $100 and the Student Prize $50, plus certificates. Winning papers will be published in the Journal of Professional Practice. When the excellence of more than one paper justifies it, the committees may designate a "second order of merit."

Papers, selected in preliminary competition, must be mailed to Society headquarters by May 1, 1961, the closing date for the 1961 competition.

ECPD Guidance Committees Recruit Students

The first step toward achieving the large number of engineers needed to meet the future needs of industry, education, government, and private practice is to attract additional qualified high school students to the study of engineering. This objective is being carried out by the Guidance Committee of the Engineers Council for Professional Development through a network of state committees that work directly with the schools.

Each year hundreds of engineers from the ECPD State Committees visit high schools across the country to tell the students about engineering and the aptitudes and preparation required for a career in the field. Through special projects and meetings, vocational counselors, mathematics and science teachers, and the parents of high school students are also told about the career opportunities engineering offers to qualified students. To expand this important ECPD guidance program, the help of more engineers is needed.

The ECPD State Committees were organized during the Korean War when the shortage of engineers was reaching critical proportions. There are now committees in all 50 states, the District of Columbia, and Canada. The work is coordinated by the ECPD National Guidance Committee through eight regional chairmen. At times engineers, both individually and in groups, have undertaken engineering guidance work without being aware of the coordinating role exercised by ECPD. To avoid this duplication, which has led to difficulties with school authorities engineers interested in guidance are asked to join in the ECPD program rather than independent programs. This will mean a unified approach to the recruiting situation.

The ECPD State Committees make use of a variety of programs to arouse interest in engineering. These include talks and panel presentations, films on engineering, inspection trips, promotion of high school engineering clubs and science fairs, television and radio programs, individual counseling, and many other activities. National Engineers' Week is used by many committees as a focal point for special guidance projects. The committees change and modify their programs each year as new ideas are tried out.

The ECPD National Guidance Committee supports the work of the State Committees through two annual mailings to the nation's 30,000 high schools. The mailings provide the principals and counselors with literature on engineering and include a form which can be used to request guidance assistance from the ECPD State Committees.

Information on engineering is also sent to the directors of Summer Institutes sponsored by the National Science Foundation for mathematics and science teachers and by the U.S. Office of Education for counselors. Last summer, 485 Institutes, with an estimated enrollment of 16,000 teachers and 3,800 counselors, were reached in this way. Each Institute director was offered the assistance of the local ECPD Guidance Committee in arranging sessions devoted to engineering. The National Guidance Committee also keeps ECPD guidance pamphlets under review, makes revisions as necessary, and introduces new items for the use of the State Committees.

Further expansion of guidance programs is limited only by the number of engineers willing to help. Thousands of engineers are already giving unstintingly of their time to this activity. However, the help of still more is needed. ASCE members who are able to help with this important work should first check to see what their Section may already be doing in the field. Many Sections carry out special projects in cooperation with the program of their State ECPD Guidance Committee. Some engineers may prefer to volunteer their services as a speaker directly to the ECPD chairman for their region. The regional chairmen are listed here:

Region I (New England): R. H. Stockard, Director of Placement, University of Rhode Island, Kingston, R. I.

Region II (New York and New Jersey): Prof. H. F. Roemmele, Placement Officer and Director of Alumni Relations, The Cooper Union, New York 3, N. Y.

Region III (Delaware, D. C., Maryland, Pennsylvania): D. M. Seeley, Executive Asst. Eng., U.S. Steel Corp., 525 William Penn Place, Pittsburgh 30, Pa.

Region IV (Southern States): Prof. John C. Reed, Head, Dept. of Mech. Eng., University of Florida, Gainesville, Fla.

Region V (Indiana, Kentucky, Michigan, Ohio, West Virginia): G P. O'Connell, Asst. Mgr., Educational Relations, General Motors Corp., 3044 W. Grand Blvd., Detroit 2, Mich.

Region VI (Illinois, Iowa, Minnesota, Missouri, Nebraska, North and South Dakota, Wisconsin): Dean A. B. Drought, Marquette University, 1515 W. Wisconsin Ave., Milwaukee 3, Wis.

Region VII (Arizona, California, Idaho, Montana, Nevada, Oregon, Utah, Washington): Robert Matteson, California Research Corp., Box 1627, Richmond, Calif.

Region VIII (Arkansas, Colorado, Kansas, Louisiana, New Mexico, Oklahoma, Texas, Wyoming): J. G. McGuire, Asst. Dean, School of Eng., Texas A. & M. College, College Station, Tex.

Canada: Roger Lessard, Ecole Polytechnique, Montreal, Quebec.

Alaska: Prof. Charles Sargent, University of Alaska, University, Alaska.

Hawaii: Prof. B. M. Harloe, University of Hawaii, Honolulu 14, Hawaii.

Summer Institutes For Engineering Teachers

This summer the National Science Foundation will help 20,000 high school and college teachers of science, mathematics, and engineering go back to school to take a new look at the subjects they teach and the ways they have been teaching them.

Grants totaling nearly $22.7 million to 260 colleges and universities have been made in support of 395 summer institutes in 1961 as part of the Foundation's efforts to increase the classroom effectiveness of teachers. The summer institutes offer teachers study opportunities in courses especially designed to (1) refresh their knowledge of fundamentals, (2) acquaint them with recent developments in science and mathematics, and (3) familiarize them with new approaches in presenting subject matter. Typically, summer institutes accept about 50 applicants for sessions usually lasting six or eight weeks.

Participants are chosen by the staff of the institute and not by the National Science Foundation. Inquiries and applications for participation should be addressed to directors of the institutes. A list, designating these host institutions, the amount of the Foundation grant for each institute, and the special field of study, if any, may be obtained from the National Science Foundation, 1951 Constitution Avenue, Washington 25, D. C.

Photographed during Kansas City Section Power Conference were (left to right) Ray Lawrence conference chairman; Brig. Gen. A. W. Betts, featured luncheon speaker; Henry Benjes, program chairman; W. R. Gibbs, vice president of Kansas City Section; and Jack Daily, president of Section.

Kansas City Section Sponsors Power Conference

The Kansas City Section sponsored another highly successful technical conference on November 10 and 11. At this year's conference an outstanding group of key men in the power industry gave broad coverage to the aspects of power which are of prime interest to civil engineers.

In the keynote address Walker L. Cisler, president of ASME and of the Detroit Edison Company, highlighted the conference theme, "Progress in Power," with his gaze into the future of the power industry. On the basis of reports of the Electric Power Survey Committee of the Edison Electric Institute, Mr. Cisler indicated that the industry must face the job of virtually doubling its capacity every ten years if anticipated demands are to be met. It is predicted that the peak load in December 1985 will be somewhere between 540 and 760 million kilowatts as compared to the 125 million kilowatts in 1959.

Francis L. Adams, chief of the Bureau of Power of the Federal Power Commission, likewise predicted a rapid rate of expansion though the government figures are slightly lower. Hydroelectric installations account for about 18 percent of our total generating capacity. According to Mr. Adams, we have developed less than one-quarter of this country's hydroelectric power potential of 146 million kilowatts. In spite of the optimistic future of potential hydro projects, Mr. Adams predicted a relative decline to only 13 percent of our total generating capacity by 1980.

Brig. Gen. A. W. Betts' luncheon talk on "Making Power with Rockets" provided an interesting conclusion to the conference. In space, where the ratio of weight of the generating system to the power developed is of prime importance, the use of hot rocket exhaust gases to generate electric power through thermionic processes holds great promise.

Conference registrants came from as far as California, North Carolina, and New York.

Civil Engineer Wins Alfred Noble Prize

This year's winner of the Alfred Noble Prize is Ronald T. McLaughlin, Jr., A.M. ASCE, whose prize-

winning paper on "The Settling Properties of Suspensions" was published in the Hydraulics Division Journal for December 1959. The prize consists of $500 in cash and a certificate.

Presentation of the award to Mr. McLaughlin will take place at the first Society or Section meeting he is able to attend. At present he is with the Ministry of Public Health in Bangkok, Thailand. A 1951 graduate of Queen's University, Kingston, Ontario, Mr. McLaughlin did graduate work in civil and chemical engineering at California Institute of Technology. He received his Ph.D. in 1958. He served as instructor and research fellow in engineering at Caltech before going to Thailand this past summer.

The Alfred Noble Prize—a joint award of the Founder Societies and the Western Society of Engineers—was established in 1929 in honor of Alfred Noble, Past President both of ASCE and of the Western Society of Engineers.

Bibliography on Airport Engineering

A new comprehensive *Bibliography on Airport Engineering*, published by ASCE, chronicles and catalogs the engineering papers, articles, and reports that appeared in the publications of the free world from 1938 to 1959. It has grown out of the file maintained by the author, Shu-t'ien Li, F. ASCE, which has been augmented and verified in technical libraries all over the United States.

Identified as ASCE Publication 1960-41, the bibliography is divided into 26 chapters and has a total of 2,335 entries. The subjects covered include location and planning, design and maintenance, earthwork, drainage, pavements (both rigid and flexible), lighting, hangars, heliports, and unit costs. Of special importance at this time is a chapter (with 169 entries) dealing with launching bases, space stations, and allied subjects.

The list price for this 184-page hard-bound book is $8.00; ASCE members and libraries receive a 50 percent discount. Copies can be ordered from the Executive Secretary, ASCE, 33 West 39th St., N.Y. 18, N.Y. Remittance should accompany orders.

ASCE ENGINEERING SALARY INDEX

(Prepared Semiannually)

Consulting Firms

City	Current	Previous
Atlanta	1.21	1.38
Baltimore	1.14	1.14
Boston	1.23	1.22
Chicago	1.49	1.45
Denver	1.25	1.24
Houston	1.26	1.26
Kansas City	1.15	1.13
Los Angeles	1.32	1.28
Miami	1.38	1.57
New Orleans	1.22	1.18
New York	1.29	1.25
Pittsburgh	1.07	1.07
Portland (Ore.)	1.24	1.27
San Francisco	1.34	1.30
Seattle	1.06	1.06

Highway Departments

Region	Current	Previous
I, New England	1.03	1.01
II, Mid Atlantic	1.15	1.14
III, Mid West	1.29	1.27
IV, South	1.12	1.12
V, West	1.16	1.06
VI, Far West	1.17	1.17

Sole purpose of this Index is to show salary trends. It is not a recommended salary scale. Nor is it intended as a precise measure of salary changes. The Index is computed by dividing the current total of base entrance salaries for ASCE Grades I, II, and III, by an arbitrary base. The base used is $15,930, the total of salaries paid in 1956 for Federal Grades GS5, GS7 and GS9. Index figures are adjusted semiannually and published in CIVIL ENGINEERING. Latest survey was July 30, 1960.

The Younger Viewpoint

Committee on Younger Member Publications

Walter D. Linzing, Chairman; 4751 No. Paulina, Chicago 40, Ill.

Zone I	Zone II	Zone III	Zone IV
Donald Kowtko 289 Foxhill Road Denville, N. J.	Albert C. Nelson 250 N.E. 51st Street Miami, Fla.	William R. Walker 4600 Franklin Ave. Western Springs, Ill.	Judd Hull 6000 S. Boyle Ave. Vernon, Calif.

This month's article was sent in by Bill Walker, Zone III representative of the Committee on Younger Member Publications. The article deals with the application of engineering education and looks into the future at changing concepts of a technical education.

Engineering education too specialized?

The Oct. 10, 1960, issue of *Time* magazine discussed in a general way civil engineering curriculum changes at Massachusetts Institute of Technology. According to the *Time* article, "today's civil engineer can build a bridge, but what else can he do? In an age when technological breakthroughs occur almost overnight, many U.S. educators fear that engineering courses have become so specialized and formula-bound that they contain the seeds of their own obsolescence." Recently M.I.T. announced that it is revamping its civil engineering curriculum to roll with the future.

It is not enough, says M.I.T.'s Dean of Engineering Gordon S. Brown, to try to match technological advances by adding a new course here, another there: "This produces a hodgepodge, a Christmas tree that you keep adding lights to, never quite being able to keep pace with the changes that are taking place all the time."

Civil Engineering curriculum revamped

"M.I.T.'s new plan," according to *Time*, "is a systems approach, which is spreading throughout its engineering departments in a $9,275,000 overhaul financed by the Ford Foundation. On the premise that specialized skills can be learned on the job after graduation, M.I.T.'s civil engineering students will take courses in modern physics, thermodynamics, electrical engineering, statistical theory, operations research [an organized and systematized study of complex situations, such as arise in the activities of risk-taking organizations of peoples and resources] and computer development. They will also study social and political factors that influence engineering applications." *Time* quotes M.I.T.'s Dr. John Wilbur, F. ASCE, as saying, "All the structures, ground facilities and processes that adapt and control environment are the concern of the civil engineer."

ASCE Members comment

Following are solicited comments on the *Time* article from the ASCE Student Chapter at Northwestern University; Associate Member John F. Seidensticker, a civil engineering graduate in 1957; and Dr. John A. Logan, chairman of the civil engineering department at Northwestern.

An Associate Member's viewpoint

John F. Seidensticker gives his opinion:

"The new curriculum to be installed at M.I.T. and described in the article [summarized here] is apparently aimed at broadening the engineering base of the student. This is to be done at the expense of specific courses teaching the techniques of engineering, and in their place are substituted courses to acquaint the civil engineer with all the variations in civil engineering which he may encounter. The question is, what is the student who receives the curriculum best prepared to do?

"It seems to me that the program at M.I.T. is aimed at preparing an engineer for filling one of two general positions. One involves an engineer who will go through the training program of a large corporation and will then be placed in some department of that organization commensurate with his interests and abilities. The second choice is that they are preparing an engineer for a management position, where such factors as political science and sociology will become more important. However, we know that the civil engineer to a large extent is employed by small companies or by consultants and is expected to be familiar with specific techniques and know-how upon graduation. In a consultant's office he would have less opportunity to use the knowledge of the effect of social and political factors related to engineering until he achieves a position of high responsibility, and the time element to attain this position is of the order of many years. . . .

"My personal impression is that engineering schools should be more intent upon preparing students for the type of office in which they will find themselves working and leave the responsibility for a more liberal education to the initiative of the individual following graduation. If he does not further his education after graduation, it is improbable that he would have the inspiration to be a leader.

"It appears that M.I.T. is broadening the base of engineering education at the expense of specific technical know-how, and this may not be in the best interest of the practicing civil engineer."

—JOHN SEIDENSTICKER
Chicago, Ill.

Northwestern Student Chapter comments

"This year the civil engineering seniors at Northwestern University broke with tradition by proposing a new approach to their final-term senior design project. In the past this course has undertaken the design of projects ranging from a floating radar station to the redevelopment of a business district. While these projects have made good use of the students' technical skills, the underlying purpose of the course—to relate and integrate the various disciplines of civil engineering into a professional entity—has usually not been achieved. In their proposal to the faculty this year, the seniors suggested that an environmental control and systems analysis approach to a regional development study would best fulfill the goals of the course. In addition, such a project would be a direct application of the recently defined purpose of civil engineering—the fulfillment of human needs through the adaptation and control of the physical environment. . . .

"Environmental control will provide a framework in which the student can relate and bring into perspective not only the various courses in engineering science, analysis and design, but also the general education courses in the areas of social science, the humanities, and communications. . . .

"As students who have had considerable exposure to the environmental control concept, we certainly encourage the recognition of this approach as the basis of the civil engineering profession. . . . Already M.I.T. is discussing the possibility of sweeping changes in its curriculum, while other schools, like Northwestern, are taking a more conservative approach with initial changes taking the form of a shift of emphasis within the existing course framework. . . .

"As seniors about to enter the profession, we urge all civil engineers to study and evaluate these proposals carefully. The future of civil engineering as a profession and as a service to mankind may well be tied to the acceptance of the concept of environmental control."

Engineering educator replies

"The proposed new civil engineering curriculum at M.I.T. is an important step in the right direction. It recognizes the need for an over-all objective—environmental control—and it introduces what may be a revolutionary new tool, systems analysis. . . .

"Environmental control provides the profession with an objective of a truly professional kind, a philosophic umbrella under which the diverse specialties in the field can be integrated in a meaningful way.

"Systems analysis has made its major advances in recent years following its adoption by the economists and management. . . . It now gives promise of a major breakthrough in such fields as the analysis and design of space frames, city and regional planning, water resources development, etc. It provides a logical approach to the field of engineering decision-making and should be welcomed equally by those who want to see civil engineering made more scientific and by

those who want to place more emphasis on the art of the profession.

"The changes in the M.I.T. curriculum are incompletely described in the *Time* article. However, the need for change has been recognized by two important national conferences held during the past year: the ASEIB-sponsored meeting on sanitary engineering education in Cambridge and the Cooper Union-sponsored conference [ASCE and ASEE were also sponsors] on civil engineering education held in Ann Arbor. M.I.T.'s action, coming so soon after these meetings, provides engineering schools with guide lines that appear to be based on at least some of the concepts that were favorably discussed at both meetings. It is a foregone conclusion that the new curriculum will be studied avidly by every department in this country and by many overseas. It is my opinion that it will be an important force for constructive change."

DR. JOHN A. LOGAN
Northwestern Univ.

Comments welcome

Members of ASCE, this is your column. We welcome your comments and observations. Please send your letters to any of the Zone representatives or the chairman of the committee.

New Officers for EJC

James N. Landis, vice president of the Bechtel Corporation of San Francisco, was elected president of Engineers Joint Council at a recent meeting of the Council's Board of Directors held in New York. Mr. Landis, who is past president and present Council member of the American Society of Mechanical Engineers, succeeds Augustus B. Kinzel, vice president of Union Carbide, who headed EJC for the past year.

Mr. Landis' engineering career has been mainly in the power field. He joined the Brooklyn Edison Co. in 1923 and remained until 1936. He was with Consolidated Edison from 1936 to 1948, serving as head of contract control and inspection and assistant mechanical engineer. Joining Bechtel in 1948 as chief power engineer in charge of engineering design and layout of steam-power plants, he became vice president in 1953.

The Board reelected George E. Holbrook as vice president for another year. He is past president of the American Institute of Chemical Engineers and vice president of E. I. du Pont de Nemours & Co.

ASCE Forms Council to Fight Air Pollution

At the suggestion of the Sanitary Engineering Division, the Board of Direction has authorized formation of a Research Council on Air Resources Engineering. The objective of the new Council is "to advance engineering knowledge and practice through stimulating and guiding research and assisting the financing of it in the field of air pollution control; to organize research projects; to interpret the findings of such research in cooperation with professional committees; and to make available information and recommendations resulting from such research."

Named to the Council, as it starts its work, are William T. Ingram, chairman; Dwight F. Metzler, representative of the Sanitary Engineering Division to the Council; and Albert F. Bush, William S. Foster, Ralph C. Graber, Alvin F. Meyer, Jr., and August T. Rossano, Jr.

There are many reasons for the studies, as reported by the Council. The Council points out that the direct cost of polluted atmosphere in the United States runs to at least $10 per capita year year. Attention to the situation has been emphasized by such major catastrophes as the Donora, Pa., incident and similar experiences in Holland and England. The Council also points to some favorable experience, such as Pittsburgh's successful program to clean up its air.

One of the Council's early projects will be the conduct of a symposium to focus attention on the major research needs in this area, and to assist in the selection of research projects worthy of organization and support.

United Engineering Center Nearly Enclosed

Glass and spandrelite enclose the first ten floors of the United Engineering Center, while stainless steel mullions extend four stories higher. Photo, taken early in December, showed that only five courses of limestone remain to be placed. With recent settlement of strikes in the construction industry threats of delay have been eliminated.

ASCE Membership as of December 9, 1960

Fellows	11,219
Members	16,246
Associate Members	19,173
Affiliate Members	113
Honorary Members	47
Total	46,798
(December 9, 1959	44,435)

ASCE CONVENTIONS

PHOENIX CONVENTION
Phoenix, Ariz.
Hotel Westward Ho
April 10-14, 1961

ANNUAL CONVENTION
New York, N. Y.
Hotel Statler
October 16-20, 1961

HOUSTON CONVENTION
Houston, Tex.
Hotel Shamrock
February 19-23, 1962

TECHNICAL DIVISION MEETINGS

CONFERENCE ON ENVIRONMENTAL SANITATION AND URBAN PLANNING
Evanston, Ill.
Northwestern Technological Institute
March 21-22, 1961
Sponsored by
Sanitary Engineering Division
City Planning Division

AIR TRANSPORT CONFERENCE
Miami Beach, Fla.
Carillon Hotel
May 11 and 12, 1961
Sponsored by
Air Transport Division
Airport Operators Council

SYMPOSIUM ON WATER RESOURCES AND RECLAMATION
Fort Collins, Colo.
Colorado State University
June 12-15, 1961
Sponsored by
U.S. Bureau of Reclamation
Colorado State University
ASCE

HYDRAULICS DIVISION CONFERENCE
Urbana, Ill.
University of Illinois
August 16-18, 1961
Sponsored by
Hydraulics Division

DISTRICT CONFERENCES

NEW ENGLAND COUNCIL
Boston, Mass.
Massachusetts Institute of Technology
March 25, 1961

PACIFIC SOUTHWEST COUNCIL
Phoenix, Ariz.
Hotel Westward Ho
April 10-14, 1961

PACIFIC NORTHWEST COUNCIL
Spokane, Wash.
April 21-22, 1961

NOTES FROM THE LOCAL SECTIONS

(Copy for these columns must be received by the fifth of the month preceding date of publication)

Research in high strength bolted joints which has been carried on in the past four years has been incorporated in new specifications which now allow an almost 50 percent increase in the allowable shearing stress of a bearing high strength bolt. At the **Lehigh Valley Section's** October meeting John L. Rumpf, professor of civil engineering at Drexel Institute, presented a resume of Lehigh University's portion of this research which was carried out under his supervision. He showed that for the ratio of net tensile stress of the plates to the shear stress on nominal area of the bolts in a joint, the 1954 specifications of 1.00 to 0.75 were unduly conservative and that a ratio of 1.00 to 1.10 would provide a balanced design at ultimate loads. This ratio would allow a shear stress of 22 ksi on the nominal area of the bolts when 20 ksi in tension is allowed in the net section of the plates; hence the almost 50 percent increase in the shear stress of the previously allowable 15 ksi.

Over 150 engineers, guests and students met at the University of Maine campus for the eleventh annual Maine Highway Conference, sponsored by the **Maine Section** in cooperation with the Maine Highway Commission and the University of Maine Student Chapter. Dean Weston S. Evans, former ASCE Director, spoke at the Friday luncheon on the breadth of interest of ASCE—both in technical and professional matters; on the progress of the United Engineering Center; and on the dedicated work of ASCE committees. For two days there was a procession of high-caliber papers on frost action in soils. First prize in the student category of $40 went to Richard A. Johnson for his paper on frost control problems in small footings. Prizes of $20, $10 and $5, awarded respectively to Stanley Walker, who equated the magnitude of heave to the depth of ice lenses; Harold Hollingsworth, who stressed the factors necessary in ice to heave; and David Stevens, who noted the twin evils of differential frost heave and loss of subgrade strength in thawing. All prizes in this category were donated by the New England Road Builders Association. Subsequent papers on the conference theme were given by representatives of the highway departments of neighboring states and by other nationally recognized specialists in the field. A $25 award for the best conference paper was given W. Keith Boyd, chief, Frozen Ground, Applied Research Branch, Snow, Ice and Permafrost Research Establishment, for his paper "Construction in the Polar Regions."

(Continued on page 78)

Don Mattern (second from left), Zone II Vice President and chief of the Project Planning Section of the Tennessee Valley Authority in Knoxville, congratulates Prof. C. F. DeVilbiss (second from right), of the Vanderbilt University civil engineering department, on his election as president of the Nashville Section. Other new officers are Secretary-Treasurer W. H. Cannon (left) of Barge, Waggoner & Sumner and Vice President Alexander Koltowich (right) of Clarke & Rapuano.

Henry W. Buck (standing), Director of District 2, was among those attending the recent dinner-meeting of the Rhode Island Section which heard a panel discussion between engineers and contractors on their mutual problems. Seated to the left of Director Buck is Howard W. Holmes, partner in Charles A. Maguire & Associates and a panel member; while Kendall Moultrop, president of the Rhode Island Section, is at his right.

Samuel B. Folk (left), professor at Ohio State University; Grant Hinkamp (center), chief construction engineer for Floyd G. Browne & Associates; and Guy H. Elbin, Franklin County Engineer, show their approval of the Life Membership Certificates awarded them by the Central Ohio Section recently. Two others, Floyd G. Browne, owner of Floyd G. Browne & Associates, and Carl H. Tozzer, partner in Tozzer & Associates, were not present.

Sylvester L. Poor was elected Section president; Edward C. Jordan, first vice president; George K. Wadlin, second vice president; Frank M. Taylor, treasurer; John P. Hennings, secretary; and Page Johnson, director for a two-year term.

The **Oklahoma Section** has elected Allen G. Poppino, chief structural engineer for the Benham Engineering Company at Oklahoma City, as its new president. Also elected was Joseph E. Perry, Army Corps of Engineers, as vice president; while James W. Gillespie, Oklahoma State University faculty member, continues as secretary-treasurer.

An important "first" was accomplished at a recent meeting of the **Philadelphia Section** when William W. Eshbach, partner in the architectural firm of Eshbach, Pullinger, Stevens and Bruder; Samuel I. Sacks, attorney and civil engineer; and William Padlasky, partner in the consulting engineering firm of Schulcz and Padlasky and Section vice president, discussed "Engineer-Architect Cooperation." The speakers have been for many months engaged in a meeting-of-the-minds through joint committees at local, state and national levels, seeking solutions to the many perplexing problems which beset the two closely allied professions in their daily work. Results of their work are evident in the formation of a local committee on cooperation. The committee has been meeting regularly for the past two years. Serious attempts are being made to clarify the many vague and ambiguous facets which are inherent in the development of a building project, through negotiations and conference among owner, architect, engineer and manufacturer. It is in the regions of conflict that the local committee is striving to achieve bases of resolution. By adjournment time Section members had a clearer idea of the composition and function of the all-important committee and the legal aspects of registration acts for architects and engineers in various state legislatures that have resulted in the lack of uniform limits of duties beyond which each profession may not perform without the other's participation or approval. At present an attempt is being made to evolve an ethical code which would be honored by both professions.

The Construction Division of the San Francisco Section held its final meeting of the season on November 17. Retiring Chairman Joe Kaplan (seated, right) receives the accolade of the new chairman, Phil Beiser (standing), and of the more than 100 members and guests present.

LOCAL SECTION MEETINGS

Central Pennsylvania—Dinner meeting at Castiglia's Restaurant, Harrisburg, Pa., on January 19, at 6:00 p.m.

Cleveland—Thirty-fifth annual banquet at the Cleveland Engineering and Scientific Center, the evening of January 20.

Hawaii—Honolulu Post Convention Tour following the 1961 Phoenix Convention, April 20-21.

Los Angeles—Dinner meeting of the Pipeline Group at the Engineers' Club in the Biltmore Hotel, on January 17, at 6:30 p.m.; dinner-meeting of the Soil Mechanics Group at the Engineers' Club in the Biltmore Hotel, on January 18, at 6:30 p.m.; dinner-meeting of the Sanitary Engineering Group at the Engineers' Club in the Biltmore Hotel, on January 25, at 6:30 p.m.; and dinner-meeting of the Transportation Group at the Engineers' Club in the Biltmore Hotel, on January 26, at 6:30 p.m.

Metropolitan—Regular monthly meetings in the Engineering Societies Building on the third Wednesday of each month, at 7:00 p.m.

Mid-South—Annual Spring meeting in Vicksburg, Miss., April 27-29. Host for the occasion is the Vicksburg Branch.

Nebraska—Highway conference at the Cornhusker Hotel, Lincoln, Nebr., on February 11, beginning at 9:00 a.m. and culminating with an evening banquet.

Philadelphia—Regular monthly meeting at the Engineers' Club on February 14, at 7:30 p.m.

Sacramento—Weekly luncheon meetings at the Elks Temple every Tuesday, at 12 noon.

South Carolina—Annual winter meeting with the South Carolina Society of Engineers at the Wade Hampton Hotel, Columbia, S.C., on January 27.

Wisconsin—Regular monthly meeting at the ESM Building, Milwaukee, on January 26.

BY-LINE WASHINGTON . . . .

A series of three unconnected—but strongly related—developments held civil engineers' interest in late December, as Washington waited for a new Administration and a new Congress to take over:

1. The Bureau of the Budget announced results of a survey of salary ranges for government personnel, which showed (*a*) that even the highest-paid engineers in government service receive from $500 to $1,300 less than their counterparts in private industry; (*b*) that the government has been so diligent in looking after its lowest-skilled clerks, typists, office boys, etc., that this classification averages considerably more than it can make in private employment. Engineers in starting government grades get an average of $4,345 a year, compared to $6,371 in industry; engineers starting in the highest government grades get an average of $10,635, compared to $14,193 "outside." But office boys and girls get $3,185 as starting salaries from the government, compared to an average of $2,966 in industry.

2. The construction industry—including architectural and engineering services—uses far less of its graduate engineer and scientific personnel for research and development work than any other recognized industry. That's a finding in a report issued by the National Science Foundation. Where aircraft manufacturers use 65 percent or more of their technically trained people for research work, construction alone uses about 7 percent; architectural and engineering firms about 15 percent.

3. Private industry, however, spent $9.4 billion for research and development during 1959 (the last year for which figures are available), according to another NSF report. Leaders were aircraft, chemical, machinery and motor vehicle manufacturers, who between them accounted for more than four-fifths of the total expenditures in this area.

* * *

There should be more work—and more money—for consulting engineers, as a result of an experiment in pooling Roads and Housing funds for joint planning of urban development. Both the Bureau of Public Roads and the Housing and Home Finance Agency have some funds earmarked for use in planning and research work in connection with urban areas—but there has been no provision for coordination and none for pooling the available money. Under an experimental program just announced, the two agencies will set up some experimental "Joint Steering Committees" to work with local communities and engineers, using joint funds, in an effort to produce coordinated plans. In initial announcements, membership of the joint committees will go to employees (presumably some engineers) of the two federal agencies. The exact mechanics of working with a community and its own planners hasn't yet been worked out.

* * *

That "National Conference on Water Pollution," much heralded as a beginning toward a national approach to this serious problem, attracted more than 1,100 persons to Washington in mid-December, despite bad weather conditions, and produced many papers that will at least serve to bring what's known about the problem up to date. The U.S. Public Health Service—which sponsored the meeting—expected little else: Simply wanted to stir open discussion of the program and find what might be done about it. Transcripts of the discussions will of course be referred to the incoming administration and to Congress.

One thing the meeting produced, however, was confirmation of comment in CIVIL ENGINEERING that Congress will certainly push new legislation to increase funds available for community stream-pollution-control works. Both Congressman Blatnik, who was sponsor of such a bill last session, and Senator Kerr, head of the Senate's Select Committee on National Water Resources, promised action early in the new session.

Incidentally, Kerr's committee expects to bring in its final report to Congress by the end of January—after more than a year of amassing information and holding hearings in many parts of the United States. On the basis of information released so far, there's little doubt that the Select Committee will call for at least a $10 billion stream-pollution program, to cover a 10-year period; other major expenditures on improving waterways communications, recreational uses, and the like.

* * *

A legal action against the City of St. Joseph, Mo., for failure to comply with orders to build a sewage treatment plant may be resolved before it reaches court. The city was cited by the federal government, when voters turned down a bond issue that would have paid for the new disposal plant, and the case has been scheduled for the March term of a Federal district court at St. Joseph. A new bond election is set for March 7, and if voters approve the required plant the case will be dropped.

* * *

There's little hope for construction to start anytime soon on two big Pacific Northwest power dams: High Mountain Sheep and Nez Perce, both on the Snake River. The Federal Power Commission started extremely leisurely hearings on the matter in November—on the complaint of fishery and sportsmen's groups that the dams would be so high (at least 690-ft concrete structures) that no practical fishways could be devised. Then the Bureau of Reclamation weighed in with a letter to FPC to the effect that construction of the two dams is not now urgent, in view of the impending agreement with Canada for development of the Upper Columbia River. FPC attendants had already been looking forward to a summer of evidence-taking on the matter, with this further comment from the USBR—chances for the dams seem very remote indeed. The dams would be built by a private company: Pacific Northwest Power Co. of Spokane.

* * *

One result of the U.S. space effort will be of great interest to engineers: The Coast and Geodetic Survey's achievement of what it calls a "spectacular degree" of accuracy in earth measurements. By tying together a network of nine missile-tracking cameras spread over an area of 4,000 square miles, with the launching site at Cape Canaveral, Fla., the Survey claims to have achieved an accuracy of 1/16 of an inch in one mile—the width of a toothpick.

News Briefs . . .

BRI Sponsors Meeting On Preassembled Components

The building industry recently took a close and critical look at one of the major steps in its march toward better and less costly buildings—the use of preassembled components to cut down on-site construction and fabrication. A number of recommendations were made in a full-scale conference on the subject, conducted by the Building Research Institute in Washington in November.

Paul E. Baseler, executive secretary of the Building Officials Conference of America, Chicago, urged developers of such components to get together with responsible code organizations before the product is ready for use, not after, in order to help assure their acceptance.

Alan E. Brockbank, chairman of the National Association of Home Builders Research Institute, Salt Lake City, called for increased use of component parts as the main objective of home building research and cited as hindrances to progress in this direction the need for better fasteners and connectors, the doubtful dimensional stability of certain large panels, and the problem of handling components, 8 x 20 ft, generally the most economical size.

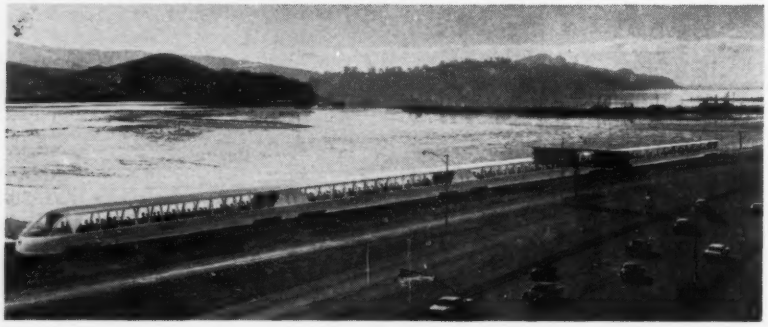
In the opinion of Ralph J. Short, director of engineering exploration for the Procter & Gamble Co., Cincinnati, many cost-reduction possibilities in the use of preassembled components are being overlooked—first, for lack of sufficient long-range research, and second, for lack of sufficient organization on each job devoted to the study of better methods.

Structural components in use include the all-metal building system devised by the American Bridge Division of the U.S. Steel Corporation, which was described by William J. Deegan, Jr., chief engineer for modular construction at American Bridge. This system uses columns prefabricated from seamless steel tubing. The exterior walls are steel curtain-wall panels, sash and door panels are preassembled commercial panels interchangeable with solid panels and containing steel aluminum or stainless steel sash. Interior walls are steel partitions. Said Mr. Deegan, "Completed buildings have performed well. They have remained weathertight through all extremes in climates varying from northern New England to southern Texas . . . but experience indicates that high-quality metal buildings are not economical for very small structures. The exact break-even point varies with the type of structure and seems to fall between 5,000 and 12,000 sq ft. The advantages increase as the size increases, as long as special items do not become too numerous. Maintenance of the buildings proper is very low . . . Damage from vandalism, accident, or disaster can be readily repaired at reasonable cost."

Of particular interest was a report of a newly completed study by the National Bureau of Standards on the new self-sealing asphalt shingles for roofs. William C. Cullen, of the Building Technology Division, stated that the Bureau's study indicates the new shingles can be considered a major improvement, since they provide a highly effective method of preventing wind damage, regardless of the variables.

Bay Area Rapid Transit—Look Into the Future

Photo rendering shows how a computer-programmed train of the proposed Bay Area rapid transit system would look running through Marin County. Train is running north from the proposed station in Sausalito. Travel time from the Sausalito station to key San Francisco points would range from 11 to 17 minutes. South-bound trains into San Francisco would use a tunnel under Fort Baker to the Golden Gate Bridge approach, then cross the bridge on a structure below the present vehicular deck. A study was recently made by the D. B. Steinman firm of the feasibility of running high-speed, rapid-transit vehicles across the bridge. A rapid-transit route between San Francisco and Marin County is a key link in the five-county, 125-mile rapid-transit system that has been proposed for the Bay area.



Contract for High-Lift Monongahela River Locks

A $14,938,579 contract for construction of new high-lift locks that will speed barge tow operations on a 42-mile stretch of the Monongahela River has been awarded to the Dravo Corporation, Pittsburgh, by the Army Corps of Engineers. The new Maxwell Locks, and a dam to be built at the site later, will be located about 5 miles above Brownsville, Pa., and will replace two existing obsolete locks and dams—No. 5 at Brownsville and No. 6 at Rice's Landing.

The new locks will have a lift of 19½ ft. Each of the two lock chambers will be 720 ft long and 84 ft wide—large enough to handle twelve standard Monongahela River barges. The larger chambers will make it unnecessary to break up all the tows and lock them in several operations.

Dravo is currently engaged in two other Corps of Engineers navigation projects on the Ohio River—new Cumberland Dam at Stratton, Ohio, and Pike Island Locks at Wellsburg, W. Va.

Graduate Scholarships In Civil Engineering

A survey of graduate scholarships, fellowships, and assistantships available to civil engineering students in 1961 has been prepared by Chi Epsilon, civil engineering honor fraternity. The graduate programs include more than 500 individual awards, with a total value of over $1,000,000.

Copies of this detailed report of opportunities for advanced study have been sent to the Civil Engineering Departments of all American and some foreign colleges and universities. Single copies are available, as long as the supply lasts, from Michael A. Spronck, Member, Supreme Council, Chi Epsilon Fraternity, Martinsville, N. J.

Generators for Niagara Power

This October the Westinghouse Electric Corporation began installation of the first of thirteen huge waterwheel generators at the Niagara Generating Plant of the $720,000,000 Niagara Power Project. The project, which is being built by the New York State Power Authority, is scheduled to begin producing power in February.

The generators, rated at 150,000 kw each, are said to be the most powerful ever built by an American manufacturer. Each weighs 1,115 tons, and the combined output of the thirteen will be 1,950,000 kw, or enough electricity to meet the total electric energy needs of a city the size of Chicago.

With an additional 240,000 kw from the nearby Reservoir Pump-Generating Plant, the Niagara Project will have a total installed capacity of 2,190,000 kw, surpassing the 1,974,000-kw capacity of Grand Coulee, the largest hydroelectric power source in the western world.

The project is being built on an accelerated schedule because of a major power shortage in the area, caused by a rockslide, in June 1956, near the Falls that destroyed a major portion of the Schoellkopf Power Station. First power is scheduled to be produced less than three years from the start of construction.

The Niagara Generating Plant is located three miles below the Falls. It has been built into the Niagara Gorge wall, from which more than 7,000,000 cu yd of excavation, mostly rock, were gouged out to accommodate it. A special access road had to be cut in the gorge wall to enable the contractors to transport heavy parts to the base of the plant for installation.

Because of the weight of some of the generator parts (the rotor alone weighs 500 tons), special low-slung trailers with tractors both in front and back had to be used to transport the parts down the gorge road. The generators are being assembled in an erection bay adjacent to the generator pits. A giant 630-ton traveling crane is used to lift the parts. The generating plant is about 1,850 feet long, the length of six football fields. From the lowest point of foundation to the top of the intake deck the plant towers 389 ft.

Public Roads Bureau Has Computer Program Library

Engineers who make use of electronic computer programs in their work will be interested in the Bureau of Public Roads' Electronic Computer Program Library. The Library was established by the Federal Highway Administrator to serve as a clearing house for receipt and distribution of computer programs developed for use in the highway field. The Library also makes it possible to minimize duplication of programs.

Programs are received from the state highway departments, consulting firms, educational institutions, Federal agencies and others. The programs are completely analyzed, checked for conformance to applicable standards, and adjusted to remove terminology peculiar to the computer for which it was developed and to assure completeness and clarity. The final library version of the program, expressed solely in English and mathematical terms, can then be coded for use with any digital computer.

The eighth of a series of memoranda, issued periodically to provide information on programs received for the Bureau's program library, programs available in library form, and other pertinent developments, is now available. It contains all the programs listed in earlier memoranda as well as those received or converted to library form since those memoranda were prepared.

Inquiries regarding the availability of these programs should be addressed to the Division of Development, Office of Operations, Bureau of Public Roads, Washington 25, D. C.

Work Starts on Chicago's Marina City Center

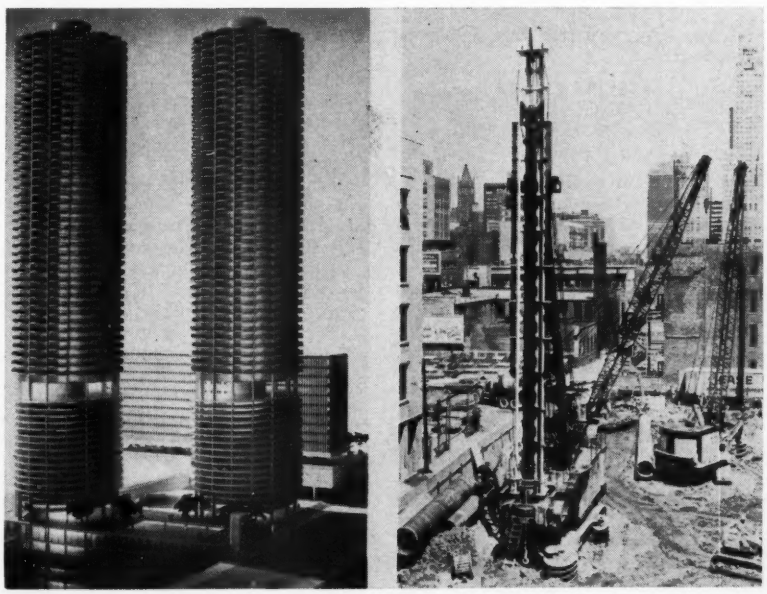
Construction of the $36,000,000 Marina City center, which will include what are said to be the two tallest apartment buildings in the world, got under way in Chicago on November 22. On that date crews of the Case Foundation Co., Roselle, Ill., started to install concrete caissons to support the two 60-story, cylinder-shaped skyscraper dwellings.

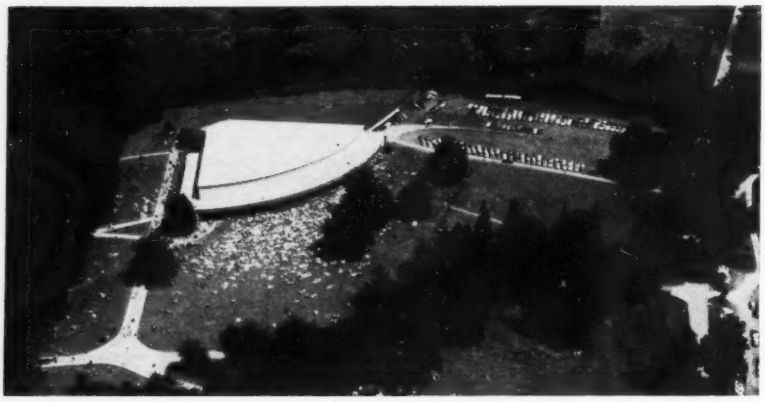
A new drilling tool, the largest in the world, will be used for the caisson work. Case Foundation has put the enormous drill in service for the first time on a major project, following months of tests in other areas. The drill, which towers nearly eight stories high and weighs more than 120 tons, was designed and built by Case engineers and mechanics at a cost of over $325,000. It is capable of penetrating practically any type of soil to a depth of 200 ft.

The Marina City project, a block-square undertaking that will take two years to complete, will consist of the twin apartment buildings, plus a ten-story commercial structure, shops and recreational facilities including a marina for 700 boats. The first 20 stories will be for parking automobiles, and the remaining 40 stories will house 896 apartments. The site is located on the north bank of the Chicago River on the edge of Chicago's Loop.

Due to the center's riverbank location, the company expects to encounter some major water problems, such as artesian wells, below ground level. These will be overcome, it is planned, through the use of special water-congealing chemicals and by inserting permanent steel sleeves in the ground to shut off the water before the caissons are concreted.

Marina City center (photo of model at left) will feature two 60-story apartment buildings. Work on the concrete caissons for the cylinder-shaped dwellings will feature use of an 8-story-high drill, said to be the largest in the world. The drill, pictured during recent tests, can bore through any type of soil to depths of 200 ft for caisson-installation work.





Tanglewood music shed in the Berkshires, a familiar sight to music lovers, was built in 1938 by civic-minded civil engineer Joseph Franz. Photo courtesy of Boston Symphony Orchestra.

Engineers Do Appreciate Culture

M. D. MORRIS, F. ASCE, New York, N.Y.

The man in the street has a cloudy conception of the engineer. Engineers (and too often the term is used to include scientists, radio technicians, and refrigerator repairmen) are purported to be soulless, bespectacled, automatons who could not tell Monteverdi from Miro, Dostoyefsky from Diaghilev, or Taoists from Tebaldi.

Contrary to this common misapprehension, engineers in general, and civils in particular, have contributed considerably to the betterment of our cultural life, over and beyond their normal pursuit of superior living conditions. One example of this is the Tanglewood music shed at Lenox-Stockbridge, Mass.

Of some 175,000 people who annually attend the Tanglewood concerts of the Berkshire Music Festival, how many have noticed the minuscule plaque mounted 6 ft up on a rear column? And of the handful who may have read this simple inscription:

JOSEPH FRANZ
ENGINEER
STOCKBRIDGE, MASS.
1938

how many have given even a thought as they attend the "world series of music" to just how much they really owe Joseph Franz? A civil engineer (ever since John Smeaton gave the practice the dignity of a profession in 1777) has been regarded as a man who can do for one dollar what anyone else can do for two. Joseph Franz, a Stockbridge citizen and engineer, upped these odds to one-for-three.

In the early thirties, two great artistic geniuses, Dr. Serge Koussevitzky, then musical director of the Boston Symphony, and his good friend, Eliel Saarinen, the noted architect, discussed in grandiose terms a dream plan for a national music center in the Berkshires. Saarinen's concept for the Tanglewood music shed and facilities was lovely and lavish. But the lowest contractor's estimated building costs were $232,000 and there was only $80,000 in the till. From his headquarters at Bloomfield Hills, Mich., the Finnish architect refused to modify even a rivet of his design, disdaining any surrender of art to economics. By 1937 Koussevitzky's dream was about to go aglimmering, when Joseph Franz volunteered his services at no fee, salvaged, and enlarged the project, without altering the overall spirit or concept.

Since there would be no occasion for scenery in a purely musical endeavor, he omitted scenery storage space in the roof, and planned it as a single—rather than double-deck unit. In the belief that to hear was far more important than to see the musicians, he reduced the slope of the floor from 12 to 3 ft, thus omitting an expensive grading operation. The floor cover material itself was eliminated in favor of tamping the earth in place. By locating the toilet facilities in the corner housings, the two promenade wings were cut out, and by moving back the last row of seats several feet, the seating capacity was increased from 4,200 to 6,000. Franz's final idea was to put three thin-section roof-support columns on a uniform radius near the center of the seating area. With this inspiration, he reduced the amount and cost of the structural steel to one-third the original plan without materially obstructing visibility. The structural design was then revised to the most basic type of simple truss. This modular design also cut the office paperwork to a minimum, as it did time and material involved in the fabrication and erection.

Franz interrupted his winter-time activity of teaching the local youngsters to figure skate, in order to make several trips to Michigan to try to convince Saarinen to accept these changes. But the architect refused to allow his name to be associated further with the project. Saarinen was paid for his work and, in 1938, Franz went on to build the now world-famous Tanglewood Music Shed for $77,768 of the available $80,000. This amount included roads, water, and sanitary facilities—everything, in fact, except provision for the unanticipated parking problem of the sixties.

Austrian-born Franz died in June 1959 at the age of 76, leaving behind a musical monument to understanding between engineers and artists.

Construction Spending Declines in November

New construction put in place in November amounted to $4.8 billion, according to preliminary estimates of the Bureau of the Census of the U.S. Department of Commerce. Although this amount represented a drop of 5 percent from October, the normal October-November decline is about 6 percent. Furthermore, the November 1960 total was 2 percent better than the year-ago total.

New private construction expenditures this past November, at $3.4 billion, were 3 percent below the level of expenditures in both October 1960 and November 1959. Spending for total public construction, at $1.4 billion, was down 10 percent from October, but up 16 percent from last November. The normal seasonal drop would be about 12 percent.

In the first eleven months of 1960, construction expenditures reached a total of $50.7 billion, 2 percent less than in the comparable period of last year. Contributing to this cumulative value were $35.8 billion in private construction and $14.9 billion in public construction.

The Bureau of the Census notes that, in making comparisons with data for 1959, estimates for the latter months of the year reflect the effects of the steel strike.

Competition Open For Welded Designs

A new competition for welded designs of machines or structures is being sponsored by the Lincoln Arc Welding Foundation. There will be 76 awards totaling $25,000 for the best papers explaining how the efficient application of arc welded steel has contributed or can contribute to progress in the design of machines or structures. Awards will be made in two separate, non-competitive divisions—Machines and Structures. Prizes in each category will range from a first award of $3,000 to 20 sixth-place awards of $100 each.

Authors must be residents of the United States, and must have participated in the design, planning, manufacture or construction of the design decribed. All papers must be mailed on or before July 17.

A booklet detailing the rules is available from the James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

Commission to Study Mississippi Pollution

Formation of a new committee to study the problem of Mississippi River pollution in the St. Louis area has been announced by the Metropolitan St. Louis Sewer District. Serious problems of sewage, water pollution, sanitation, and storm water face the District due to the tremendous growth of the Metropolitan St. Louis area. Preston Estep, chairman of the Board of the Bank of St. Louis, heads the new committee, which will review the situation and then advise the Sewer District and the community on actual needs for the immediate future.

The new committee will concern itself with two major problems. One is the most economical method of financing the control of Mississippi River pollution. The other is the problem of planning, financing, and building a network of storm sewers to serve the metropolitan area.

For Sanitary Engineers

The Robert A. Taft Sanitary Engineering Center announces two training programs in the field of water supply and pollution control. "Radioactive Pollutants in Water" is scheduled for February 12-17, and "Water Quality Management —Sanitary Engineering Aspects," for February 27-March 10.

Applications for attendance or requests for information may be obtained from the Chief, Training Program, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, Ohio.

Contract Awarded for Bridge Bus Station

Award of a $9,600,802 contract for the unique superstructure of the $13,000,000 George Washington Bridge Bus Station is announced by the Port of New York Authority. The contract goes to the low bidder, a joint venture consisting of the W. J. Barney Corporation and the William L. Crow Construction Company, both of New York. Construction will start in January and will be completed in mid-1962.

The modern two-block-long, three-level project, a part of the $183 million six-lane, lower-level project, will feature a concrete roof designed by Dr. Pier Luigi Nervi, Italian engineer-architect, famous all over Europe for his designs for sports stadia and exhibition halls. It will straddle the depressed twelve-lane George Washington Bridge Expressway between Fort Washington and Wadsworth Avenues. The new station is expected to reduce street congestion in the Washington Heights area by consolidating bus operations now being handled by scattered terminals and sidewalk stations in the vicinity.

The spectacular concrete roof of the Bus Station will consist of 26 triangular sections, 14 of which slope upward from a row of columns in the center of the building. Each triangular 92- by 66-ft section will be made of 36 concrete panels. The sides of the raised roof sections and of the Bus Station itself will be exposed concrete structural members forming openings to facilitate ventilation of the bus platforms and the expressway beneath the building.

Addition for New England Mutual Life Building

Construction has started on a $7.5 million addition to the home office building of the New England Mutual Life Insurance Company in Boston. The wings and front of the existing building will be built up to the tenth-story level of the central part of the structure, providing an additional 248,000 sq ft of office space—more than double the existing area. The clock tower, a familiar Boston landmark, will remain intact. The frame will be of structural steel with cellular steel floor decks and concrete slabs. The exterior will be of granite to match the existing facade, and the windows will be of bronze.

The Turner Construction Company, which built the existing office building, is the general contractor. Completion is scheduled for the spring of 1962.

Single Contract System of Sub-Bidding Advanced

The Associated General Contractors of American has proposed and recommended to local chapters of the American Institute of Architects use of a different system for sub-bids. At present this is limited to the prime contractors and to the mechanical and electrical subcontractors, generally known as mechanical-specialty contractors.

The plan is that the specialty contractors will submit to the prime contractors written proposals of intent to bid—detailing the precise scope of the work to be included—24 hours prior to the time the prime bid is to be submitted. The price for the work may be included with the written proposal or presented not less than four hours prior to the time for submission of the prime bid.

In submitting the bid, the prime contractor will list the name of the subcontractor he proposes to use in each of the major categories of work. In lieu of such listing, he may submit a written statement that he made an effort to secure a sub-bid from not less than three responsible subcontractors and did not get a satisfactory response.

It is hoped that the proposal will alleviate some of the contentions between prime contractors and subcontractors.

Additional information may be obtained from the Associated General Contractors of America, Inc., 20th & E Sts., N. W., Washington 6, D. C.

Sand Island Method Used to Sink Crib House

Engineers for the Cincinnati Gas & Electric Company employ the sand island method of sinking a 59-ft-dia crib house into the bottom of the Ohio River at the Walter C. Beckjord Station near New Richmond, Ohio. The 3,609-ton concrete and steel crib house is being sunk to bedrock through a 30-ft artificial island, formed by driving steel sheetpiling into the river bed in circular fashion, then filling the circle with sand. When completed, the crib house will contain the big pumps supplying condensing water for the station's new fifth (and future sixth) generating units. The new 250,000-kw generator is scheduled for completion in 1962.

Raymond Award Goes To ASCE Member

The Alfred A. Raymond Award for 1960 goes to Earle J. Klohn, M. ASCE, a professional engineer of Vancouver, B.C., for his paper entitled "Pile Heave and Redriving." Mr. Klohn is with Ripley and Associates, Ltd., a foundation engineering concern in Vancouver. His paper, considered the best of some thirty submitted to the panel of judges, deals with various forms of pile-heave problems as determined from data collected on a large pile-driving project in British Columbia.

A special award of $500 has been made to Charles E. Hall, of the International Engineering Co., Inc., San Francisco, for a second paper deemed of "exceptional quality." Mr. Hall's paper describes a blasting technique employed in compacting the foundations of a dam for the Karnafuli Project in East Pakistan.

The Raymond Award, consisting of $1,000, is given annually for the best paper on some aspect of foundation engineering. It was established three years ago in memory of Alfred A. Raymond, M. ASCE.

ASA Building Code For Reinforced Masonry

A new American Standard—*A41.2-1960, Building Code Requirements for Reinforced Concrete*—has been issued by the sponsor, the National Bureau of Standards, as Handbook 74. It is a complete code of minimum requirements for reinforced masonry construction, including definitions and requirements for materials, structural design, and allowable stresses. Prepared by the American Standards Association's Sectional Committee A41, the standard is one of a series being developed by various committees under the jurisdiction of the Construction Standards Board of the American Standards Association.

ASCE was represented on the A41 Sectional Committee by W. L. Dickey and E. A. Dockstader, with S. B. Barnes and H. W. Bolen as alternates.

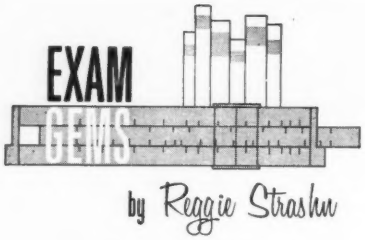
Copies of Handbook 74 are available from the U.S. Government Printing Office, Washington 25, D. C., and from the American Standards Association, Inc., 10 East 40th Street, New York 16, N. Y. The price is 15 cents.

N. Y. West Side Highway To Be Rehabilitated

A long-debated plan for repairing and renovating the West Side Highway in New York City is nearer realization with the decision of the city to ask the state for $800,000 to make plans for the $30,000,000 project. If the state provides the planning funds, and additional federal and state financing can be obtained, construction will start in 1963.

The project will be built in three stages, beginning with the downtown end, and is expected to take five years. Present plans call for resurfacing the highway between Canal and 72nd Streets, eliminating bottlenecks at entrance and exit ramps by widening the roadway to a uniform width of three lanes in each direction, and straightening curves where it is feasible.

Because the West Side Highway was originally built as part of the state's arterial road system, the state is obligated to finance any renovation, with the Federal Government reimbursing half the $30,000,000 outlay. City and state will share the estimated $3,000,000 that will be required for buying land to permit widening the roadway.



R. ROBINSON ROWE, F. ASCE

EXAMGEN No. 18 asked how much power was lost to friction in a level 10,000-ft irrigation pipeline with well and pump at one end and laterals at 100-ft intervals served with 0.05 cfs each; also how much power could be saved by a midline location of the pump. Other data were equivalent to expressing friction slope in terms of discharge:

$$s = 0.001029\,Q^2 \quad \ldots\ldots\ldots\ldots (1)$$

Response can be typed as (A) solved by iteration, (B) solved by integration, (C) nice try, (D) incoherent start, and (E) blank page. Types D and E were the majority and taught us nothing. A and B were parallel, with B near enuf by an easier analysis.

Type C usually erred in an expressed or implied assumption about losses at the laterals. For example, at the first lateral 5 cfs approaches with $v = 6.37$ fps, $h_v = 0.630$ ft; 0.05 cfs is diverted at a static head of 87 ft; and 4.95 cfs retreats at $v = 6.30$ fps, $h_v = 0.617$ ft. If the mainline deceleration is sudden, the power loss is 0.0073 hp, which is negligible or, better yet, covered by an assumption of proper design of the tee as a transition. But the 0.495 hp lost in the diversion cannot be laughed off.

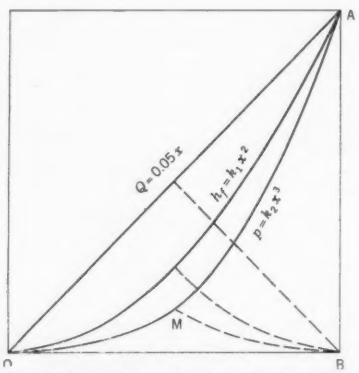


Fig. 1. Variation along a leaky pipe. Power loss is measured by area under curve OMA, but reduced to area under OMB by moving pump from B to M.

Iterating, Mr. A numbered the 100-ft sections between laterals from the far end. For the mth section, using (1) above,

$$Q = 0.05\text{m} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

$$h_f = 100\text{s} = 0.0002573\ \text{m}^2 \quad \ldots\ldots (3)$$

$$H = \sum_{1}^{\eta} 0.0002573\ \text{m}^2 = 0.00004289\text{n}\,(\text{n}+1)\,(2\text{n}+1) \quad (4)$$

$$H_{50} = 10.95\ \text{ft};\ H_{100} = 87.07\ \text{ft} \quad \ldots\ldots (5)$$

Using the power formula $P = QH/8.8$, he figured and later added the power drop in each section,

$$P_f = 0.05\text{m} \times 0.0002573\text{m}^2/8.8 = 0.000001462\text{m}^3 \quad \ldots\ldots\ldots (6)$$

$$P_f = \sum_{1}^{\eta} 0.000001462\text{m}^3 = 0.0000003655\text{n}^2\,(\text{n}+1)^2 \quad \ldots (7)$$

$$P_{f50} = 2.38\ \text{hp};\ P_{f100} = 37.29\ \text{hp} \quad \ldots (8)$$

Hence the answer to the first question is 37.29 hp. Some Type Cs answered the second by subtracting the loss from two 50-section pipelines, 37.29—4.76 = 32.53 hp, but this ignored the diverted power. From the total head on the pump in (5),

$$P_{50} = 50 \cdot 10.95/8.8 = 6.22 \quad \ldots (9)$$

$$P_{100} = 50 \cdot 87.07/8.8 = 49.47 \quad \ldots (10)$$

$$\text{Saving} = 49.47 - 6.22 = 43.25\ \text{hp} \quad (11)$$

Other Type Cs skipped (6) to (8) and gave (10) incorrectly and (11) correctly. Nice footwork, poor headwork.

Type B considered diversion essentially continuous so as to integrate at steps (4) and (7). Expressing distance in stations so as to compare with Type A, they derived:

$$Q = 0.05x \quad \ldots\ldots\ldots\ldots (2a)$$

$$h_f = 0.0002573x^2 \quad \ldots\ldots\ldots (2a)$$

$$H = 0.00008578x^3 \quad \ldots\ldots\ldots (4a)$$

$$H_{50} = 10.72\ \text{ft};\ H_{100} = 85.78 \quad \ldots (5a)$$

$$P_f = 0.0000003655x^4 \quad \ldots\ldots\ldots (7a)$$

$$P_{f100} = 36.55\ \text{hp} \quad \ldots\ldots\ldots\ldots (8a)$$

$$\text{Saving} = 48.74 - 6.09 = 42.65\ \text{hp} \quad \ldots\ldots\ldots (11a)$$

The 2 percent being "tolerable," you can take your choice, depending on your knowledge of calculus and summation of power series. The gem quality was this optional analysis and the neophyte's confusion over the diverted power.

EXAMGEM No. 19

To satisfy a compelling demand for more discussion of buoyancy, Reggie had to revive a 21-yr-old file to find this one.

Pontoons for the floating bridge across Lake Washington are 17×60×300 ft in size and made of 150-lb concrete. Slabs and walls, including 25 partitions parallel to the ends, are all 8 in. thick. Draw pressure diagram for a pontoon carrying 100 psf on one side of centerline.

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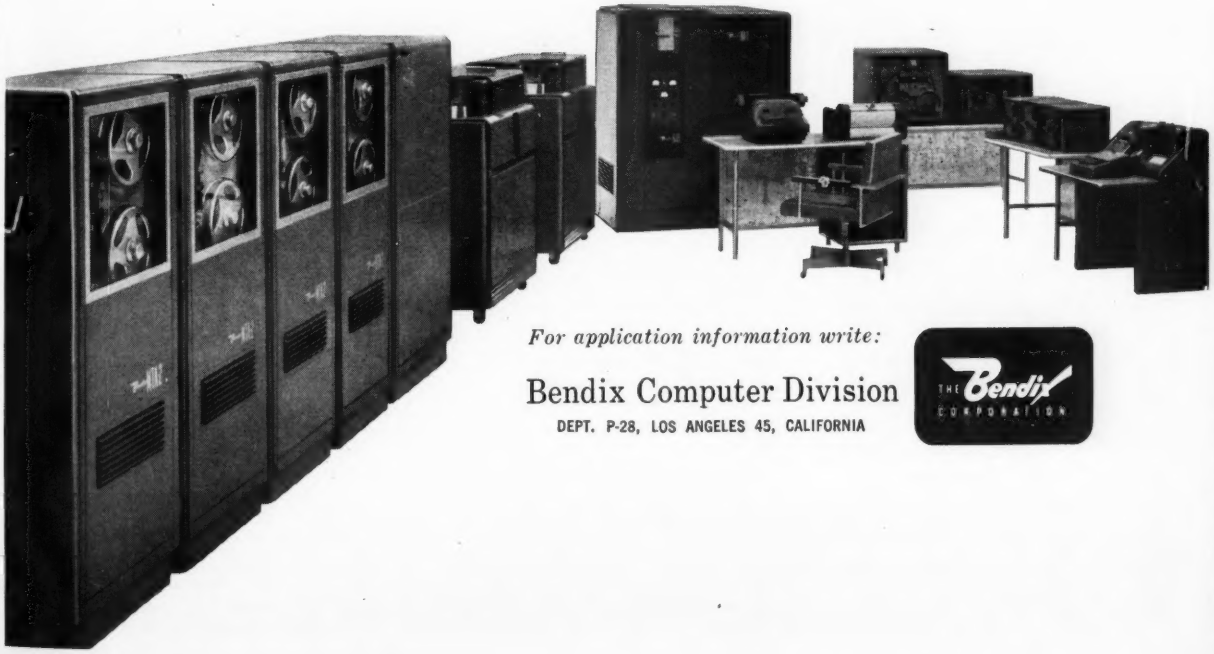
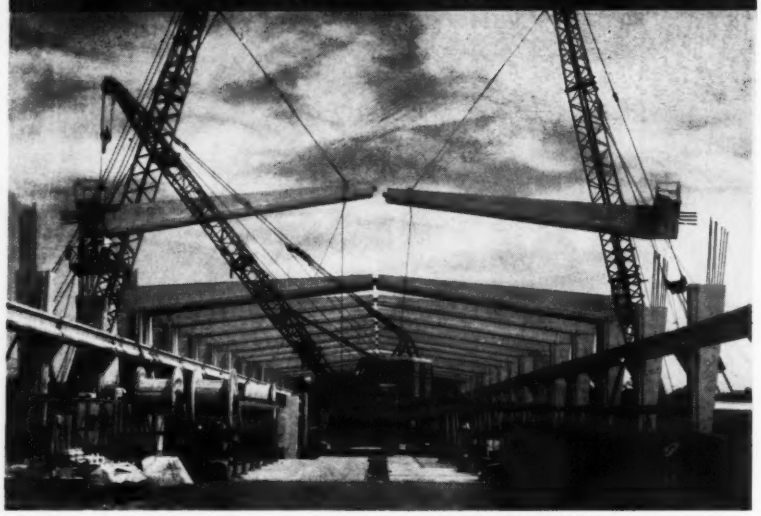


For application information write:

Bendix Computer Division
DEPT. P-28, LOS ANGELES 45, CALIFORNIA

THE Bendix CORPORATION

STRESSTEEL was the solution to this Engineering Problem



Engineers: Fredric A. Nassaux and Associates, Chambersburg, Pa.
Owners: San Vel Concrete Corporation, Littleton, Mass.

THE PROBLEM: **How to build economically a 500′ x 80′ clearspan building equipped with two 20 ton overhead cranes, to house 4 precast prestressed concrete product beds, each bed more than 310′ long.**

THE SOLUTION: **A prestressed concrete rigid frame building. The major structural elements are precast bents, post-tensioned with STRESSTEEL Bars.**

The roof girder is in two equal sections, hinged at the midpoint. The STRESSTEEL Bars in the columns extend through the ends of the roof girders and are tensioned to form an integral unit. The columns rest on footings over cast-in keys to create hinge effect.

The roof is composed of prestressed pretensioned double tee sections, which rest on the flanges of the inverted-T of the roof girder. Wall sections between columns, composed of 4" precast insulated wall panels, complete the building.

A projection is cast as part of the column to support the crane-ways for the two overhead cranes. A pretensioned I-beam rests upon them, to which the crane rails are attached.

Imaginative engineers are using STRESSTEEL Bars as the effective solution to many precast concrete problems. These high strength alloy steel bars are available in sizes up to 1¼" ∅ with recommended working stress up to 90,000 psi. Equipped with wedge or threaded anchors, STRESSTEEL Bars have been used for many unusual and special applications.

You will achieve superior results at substantial savings with STRESSTEEL because it is...

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Are you working on a special problem requiring the tying together of precast elements? STRESSTEEL's high strength reinforcement, combined with the advantages of post-tensioned prestressing, may well be the optimum solution. Ask us.

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DECEASED

William H. Alsup (A.M. '42; M. '59), age 51, owner for several years of W. H. Alsup and Associates, of Jackson, Miss., died in Jackson on November 2. Mr. Alsup retired recently because of illness. As field engineer with William E. Mallett in the early 1940's, Mr. Alsup was engaged in the design and construction of 350 defense houses at Flora, Miss., and the construction of ordnance facilities and improvements to the flying field at the Jackson Airbase.

Robert W. Anderson (A.M. '54; M. '59), age 39, for the past 14 years with the Boston firm of Ganteaume & McMullen, most recently as chief engineer, died in a plane crash in Boston recently. Before joining Ganteaume & McMullen, he was structural designer with Cleverdon, Varney and Pike, designing all types of prefabricated construction for buildings utilizing the "Latisteel" type of construction.

William M. Angas (M. '28; F. '59), age 68, retired Vice Admiral, U.S. Navy, died in Princeton, N. J., on December 12. After a 32-year naval career Admiral Angas retired in 1950 to join the department of civil engineering at Princeton University as its chairman. A former commander of the Seventh Fleet construction forces, at the time of his retirement he was director of the Atlantic Division of the Navy's Bureau of Yards and Docks and was on the staffs of the Commander-in-Chief, Atlantic Fleet, and of the Commander, Eastern Sea Frontier. In the past decade at Princeton he had taught undergraduate courses in the mechanics of materials and construction methods and graduate courses on waterfront structures and port and harbor engineering. He was also instrumental in establishing the department's rivers and harbors section.

George Mairs Bull (M. '09; F. '59), age 87, whose pioneer proposals relative to the Transmountain Water Diversions and the Eleven Mile Canyon storage dam helped Denver and Colorado obtain needed water supplies, died in Denver on November 6. In 1933 he was appointed state engineer of the Public Works Administration for Colorado, and in 1937 fifth regional director, comprising Arkansas, Colorado, Kansas, Louisiana, New Mexico, Oklahoma and Texas. In 1940 he became regional director of the Denver office of Emergency Management to obtain cooperation of industry and agriculture in meeting national defense needs. Before he went to Denver he was active on water supply and canal projects in New York State. He was called "one of Denver's great benefactors."

F. R. W. Cleverdon (M. '18; F. '59), age 79, consulting engineer and former vice president of Allen N. Spooner & Son, Inc., New York City contractors, died in New Rochelle, N. Y., on Novem-

(Continued on page 94)

Smith & Loveless Factory-Built Sewage Pumping Stations are designed for economical installation, engineered for minimum maintenance, and built to last a lifetime of dependable service.

Smith & Loveless is the world's largest manufacturer of complete, factory-built sewage lift stations with over 1,600 varied installations all over the United States, including Alaska and Hawaii—even Europe and South America, as well as Canada.

Smith & Loveless sewage pump stations are available for capacities from 100 to 4,500 GPM per pump with two, three and four pumps per station and a wide variety of control systems including variable speed controls and flow-matching systems. Even larger capacity stations are built to order.

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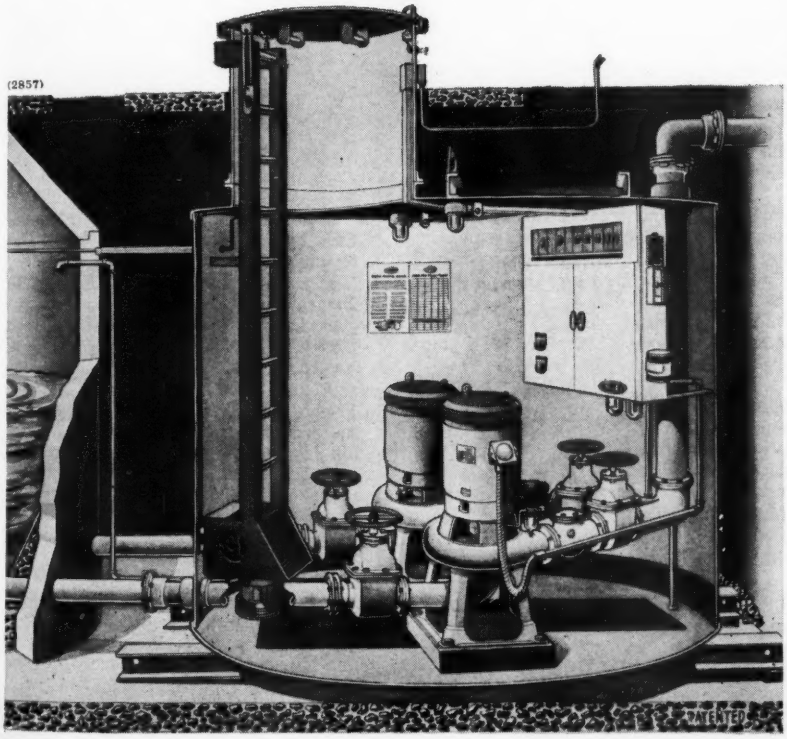

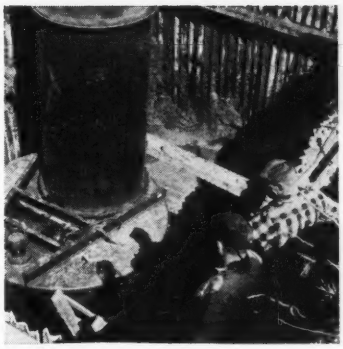

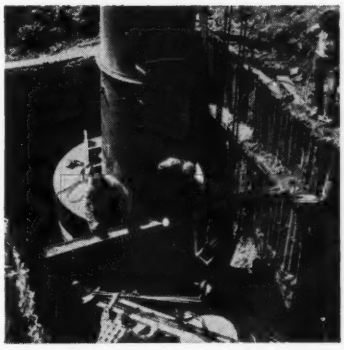

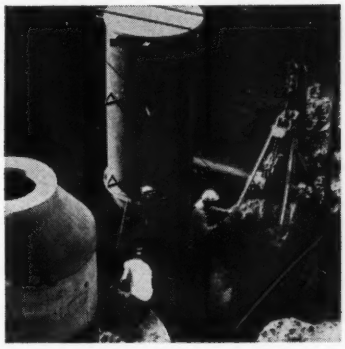

Install in less than a day by specifying a factory-built sewage pumping station that is delivered to the job site, ready to install. **For more information, write Dept. 80.**

News of Members

(Continued from page 26)

Ludwig Adams brings 20 years of experience in welding and corrosion protection to his new job as head of Sales and Technical Service at the Virginia Erection Corporation of Pittsburgh. Mr. Adams has been a director of the corporation for the past two years.

Burgess B. Brier has retired as principal civil engineer in the office of the Tennessee Valley Authority's chief engineer. Since joining TVA in its early months, he has been primarily responsible for establishing TVA's superior engineering budget procedures and methods.

A. A. Eremin, who as staff-member of the California Division of Highways Bridge Department since 1928 pioneered in the design of indeterminate bridge structures and highway tunnels, retired from the department last month. He designed the first single column bent bridge in California, the state's first box-girder bridge and both Waldo Tunnels —among the largest vehicular bores in the United States. Author of three books on the design of bridges and tunnels, Mr. Eremin has been a frequent contributor of discussions and papers to ASCE Journals.

William B. Harvey brings to the new engineering firm of Van Note-Harvey Associates, of 234 Nassau Street, Princeton, N. J., a specialized background in the fields of sanitary sewers, water distribution lines, real estate subdivisions and sewage treatment plants. Mr. Harvey, in addition, has experience in the formation and financing of municipal authorities and utilities.

Richard Y. Segawa, of Duluth, Minn., was granted a Sustained Superior Performance award for the year 1959, which carried with it a $250 cash prize for his performance as base engineer at Duluth Air Force Base. This is the fourth such award received by Mr. Segawa from the U.S. Air Force base.

James W. Goodwin, head of the Goodwin Engineering Company in Birmingham, Ala., one of the largest engineering firms in the South, became commissioner of the Birmingham Housing Authority on November 8. An engineer in Birmingham for 30 years, he is also director of the Southern-Georgia Central Gas Company as well as chairman of the board of the Carolina Pipe Line Company.

Harry Wiersema resigned his position recently as assistant to the chief engineer of the Tennessee Valley Authority to accept the post of principal planning engineer with the Development and Resources Corporation of New York. His first assignment will be in connection with planning of the proposed Salto Grande Dam on the Uruguay River at headquarters in Buenos Aires. At the time of his resignation, Mr. Wiersema was in his 27th year with the Authority.

Lawrence J. McDevitt, for the past 15 years a marketing and sales specialist for major steel companies, has joined the New York consulting firm of Ford, Bacon & Davis, Inc., as a supervising engineer in his specialty. For many years he was director of marketing research for the Crucible Steel Company of America and, more recently, has been manager of marketing research for the metals processing division of the Curtiss-Wright Corporation.

Emory Bond, Jr., has joined **Gene E. Ellis** in his offices at 4015 West 21st Street, Topeka, Kans., as a partner in the firm to be known as Ellis & Bond. In 20 years in the civil and structural engineering fields, Mr. Bond has been with Douglas Aircraft Corporation, Black & Veatch, the Kansas Highway Commission, and Servis, Van Doren & Hazard. Formerly he was president of the Kansas Section. Mr. Ellis prior to establishing his consulting practice headed the structural department at Servis, Van Doren & Hazard.

Henry D. Southerland, Jr., has been appointed Commandant of the Birmingham Army Reserve School. Colonel Southerland, assistant manager of the Land Department, Tennessee Coal and Iron Division, U.S. Steel Corporation, has been assigned to the Army Reserve School since 1953. Before joining T.C.I. in 1948, he was on the staff of the Tennessee Valley Authority.

the Priceless Ingredient

The priceless ingredient theme originally was applied to medicines, and is not new. But it can be applied to other products – even valves. Of course, the priceless ingredient in a product is an invisible force, with neither shape nor form. Yet this intangible element has set M & H apart in its field and is a prime reason for the Company's growth and prestige.

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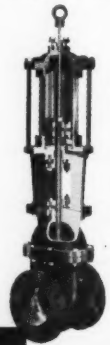

The integrity of these individuals is priceless –because it is not for sale and cannot be bought. It is the extra ingredient which is responsible for placing M & H in the forefront of the American valve and hydrant industry.

It is one of the prime reasons for the superior quality of M & H valves and hydrants which appeals so strongly to engineers, utility men and industrial operators.

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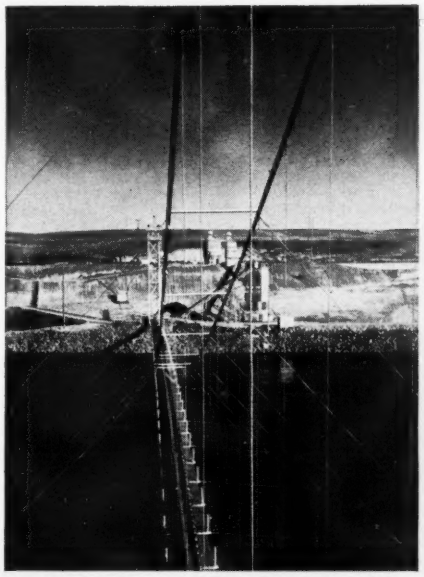

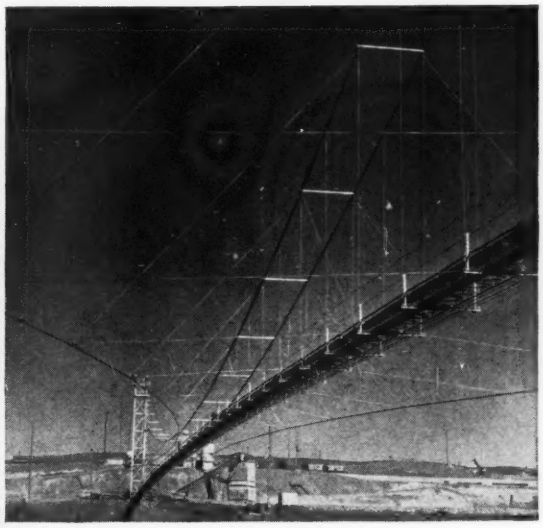

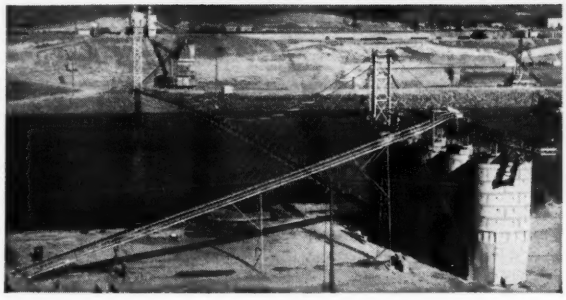

use a Roebling Conveyor Suspension Bridge

The sole purpose of this 1000-foot span, Roebling designed suspension system is to support an aggregate-carrying conveyor. The site is the Ice Harbor Lock and Dam Project at Pasco, Washington, under construction by Guy F. Atkinson Company.

The problem, and it was a large one, was to get the concrete aggregate from the South side of the river to the North side, without having to truck it some 10 miles around. The tremendous amount of concrete needed for the pouring of the dam's locks fully justified the erection of this structure. The savings in time and labor, and the assurance of an uninterrupted flow of material are additional factors that add to its value.

Of course, you don't have to build a dam before a Roebling conveyor *suspension* system can be of value to you. Your needs may be considerably more modest. You may have an in-plant (or "in-and out-plant") materials handling problem. It may be temporary or permanent.

No matter. Roebling designed and constructed suspension systems of all kinds are easing transportation problems for manufacturers and processors with speed, safety and savings. Don't think for a minute that your problem must be of the above magnitude. On the other hand, your needs may be greater. Either way—to carry your conveyor across the yard, or river, or between mountains—a Roebling suspension system can be the most economical answer. For details about your requirements, just ask Roebling's Bridge Division, Trenton 2, New Jersey.

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RECENT BOOKS

(added to the Engineering Societies Library)

American Power Conference-Proceedings, 1960

The annual American Power Conference is concerned with practice rather than theory, and a broad overall view of problems of interest to the power industry and associated groups. Six topical sessions were held at the 1960 meeting. Papers presented at the General Sessions deal with national considerations such as American economic power, national strategy, nuclear propulsion in the Navy, and the challenge of new power sources such as magnetohydrodynamic generation, isotopic heat and power, and space vehicle propulsion. All aspects of power are discussed, including distribution, communications and protection control, computers and network analyzers, and system planning and operation, power-rates, revenues, and new project financing. (Published by the Illinois Institute of Technology, Chicago 16, Ill., 1960. 869 pp., bound. $10.00.)

ASM Review of Metal Literature, 1959

The 16th annual collation of the monthly annotated survey of articles, technical papers, and reports dealing with the technology of metals, appearing in engineering, scientific and industrial journals and books here and abroad, prepared at the Center for Documentation and Communications Research, Western Reserve University, Cleveland. (Edited by Marjorie R. Hyslop. American Society for Metals, Novelty, Ohio, 1960. 1,266 pp., bound. $20.00.)

Asphalts and Allied Substances

Volume I: Historical Review and Natural Raw Materials

This sixth edition of a standard reference guide covers as before the fabrication, merchandising, and application of bituminous products, but is published now in five volumes. Volume I presents a brief historical review, terminology, classification and the chemistry of bituminous substances, and discussion of natural raw materials, including geographical locations of known world asphalt deposits, and methods of mining, transporting, refining and storage. Subsequent volumes will treat industrial raw materials (2), manufactured products (3), and methods of testing (4 & 5). (By Herbert Abraham. D. Van Nostrand Company, Inc., 120 Alexander Street, Princeton, N. J., 1960. 370 pp., bound. $10.75.)

Construction Estimates and Costs

Third Edition

A standard manual describing in detail the estimator's job, in all kinds of light and heavy construction works, from excavation through erection to the final plumbing, electrical and finishing work. Each phase is presented separately, with descriptions and illustrations of arithmetrical methods for accurately estimating costs. This revision features new material on asphalt walks, driveways and pavements, computation of equipment ownership, and operating costs. (By H. E. Pulver. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y., 1960. 617 pp., bound. $12.00.)

Digital Computers and Nuclear Reactor Calculations

A primary objective of this book is to present to the nuclear engineer or scientist an introduction to high-speed nuclear-reactor calculations. The first four chapters deal with an introduction to reactor problems, digital computers, programming, and numerical analysis, and the last four with considerations involved in actual reactor calculations. (By Ward C. Sangren. John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1960. 208 pp., bound. $8.50.)

Erecting Structural Steel

This book is for the man who has ordinary steel erection "to do" and wants to know "how". It details and names simple equipment, tells how steel is estimated, ordered and erected, and tells how a job is priced. The expert in the field will find it a review of ideas and also an excellent book to hand to the young engineer or to an embryo rigger. Both will get a lot from it. A special advantage is illustrated nomenclature so the learner can talk with the experts. The book gives basic data on all fastenings, high-strength bolts, riveting and welding and the equipment used for each. It will be helpful in any construction office. (By Samuel P. Oppenheimer. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y., 1960. 264 pp., bound. $9.50.)

Heat Transfer and Fluid Mechanics Institute—Proceedings, 1960

Contains eighteen papers—all American save for one from England and one from Belgium—presented at the 13th meeting of the Institute. The papers deal with research in vortex motion, boundary layer flows, origins of turbulence, flows not in thermodynamic equilibrium, separated flows, two phase flow systems, and thermal radiation problems in space technology. (Published by the Stanford University Press, Stanford, Calif., 1960. 259 pp., bound. $8.75.)

Introduction to Structural Mechanics

For civil engineering students in a first course in structural analysis. The general theory and the applications of that theory to structures such as roof trusses, railway and highway bridges, are treated in separate chapters. General methods rather than techniques of limited application are emphasized. (By Paul Andersen and Gene M. Nordby. The Ronald Press Company, 15 East 26th Street, New York 10, N. Y., 1960. 340 pp., bound. $9.50.)

Land for the Future

A study made under the auspices of Resources for the Future, Inc., a nonprofit corporation for research and education in the development, conservation and use of natural resources, of changing uses of land in the U.S., in the past, the present, and in the light of expectations extending to the year 2000. Most of the book is of general, albeit absorbing, interest, discussing the methodology of the study, and describing the present and the historical situation and future projects. There are, however, chapters dealing with specific uses of land, of which those dealing with urban uses and planning, and uses for transportation, water regulation, mineral production and possibly forestry will be pertinent to the engineering profession. (By Marion Clawson and others. The Johns Hopkins Press, Homewood, Baltimore 18, Md., 1960. 570 pp., bound. $8.50.)

Long-Term Trends and Problems of the European Steel Industry

Based on an extensive study begun in 1956, this publication examines world consumption and production of steel, and of steel-making raw materials, the economic consequences of technical trends, past and future, and assesses trends to 1975. The final three chapters assess the steel future in relation specifically to European activity and requirements, discussing possible solutions to some of the problems raised by the study, and indicating the nature of others. ECE cautions that the conclusions reached here are purely arbitrary, and that all long-range forecasts need to be examined periodically, and more closely detailed for application in specific regions, but add that the comprehensive statistics here assembled should be universally useful. (Published by the United Nations Economic Commission for Europe, Geneva, Switzerland, 1959. Distributed by the Columbia University Press, 2960 Broadway, New York 27, N. Y. 176 pp., paper. $2.00.)

Nutzenergie Aus Atomkernen

Volume II

This second volume on the application of nuclear energy discusses radiation hazards and reactor shielding; reviews the problems of reactor operation and control; and includes chapters on reactor installation, raw materials, and economic and legal aspects. A list of both finished

(Continued on page 96)

JOB REPORT: *NELSON Stud Shear Connectors in Composite Construction*

COMPOSITE *STEEL-CONCRETE* CONSTRUCTION...

in the new Pfizer Medical Research Laboratories

Composite construction saved 20% on steel tonnage in this modern three-story research facility which consolidates many scientific disciplines in the search for new drugs to advance better health and lengthen man's life span. According to consulting structural engineers, Garfinkel and Marenberg, by using lighter, shallower steel beams, more space was provided for the passage of piping and duct work, while minimum depth of floor construction was maintained.

Nelson stud shear connectors were welded to the top flanges of the steel floor beams and were then embedded in the concrete floor slab. Once the concrete set, the shear connectors transferred horizontal shearing forces from the beam to the concrete slab... causing the concrete and steel elements to function as a unit.

Composite construction can provide these economies and advantages for your next job... *shallower beams* to meet equal load requirements · *provide the same usable cubic area* with less building materials · *longer spans* for greater load-carrying capacity per pound of steel · *wider spacing of columns* for more unobstructed floor space.

For complete information, call in your local Nelson Field Man, or write for "Composite Construction for Buildings", Nelson Stud Welding, Division of GREGORY INDUSTRIES, INC., Dept. 10, Lorain, Ohio.

Pfizer Medical Research Laboratories, Groton, Connecticut. Architects: Shreve, Lamb and Harmon Associates • **Structural Engineers:** Garfinkel and Marenberg • **General Contractor:** W. J. Barney Corporation—all of New York City • **Structural Steel Contractor:** Elizabeth Iron Works, Elizabeth, N.J.

NELSON Stud Shear Connectors *are approved by AASHO for bridge construction.*

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Division of GREGORY INDUSTRIES, INC.

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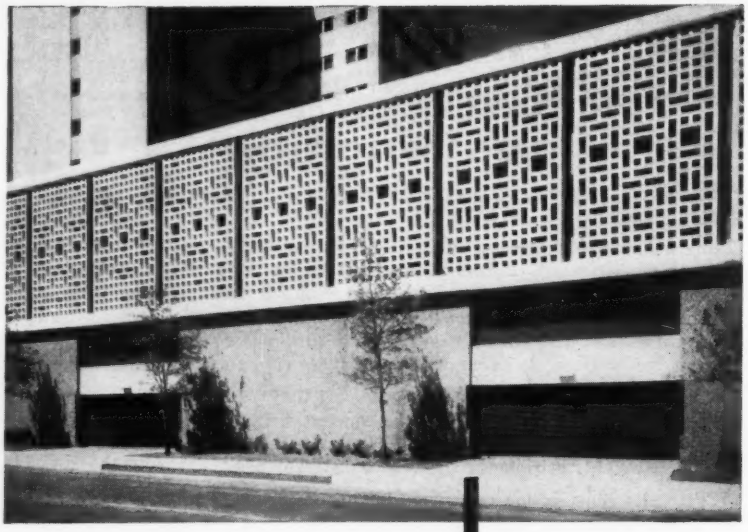

Upward-acting, all-metal grilles that block intrusion when closed, without cutting off light, air or vision . . . coil quickly out of the way above the opening whenever desirable . . . and complement the beauty of today's most distinguished buildings and architectural designs

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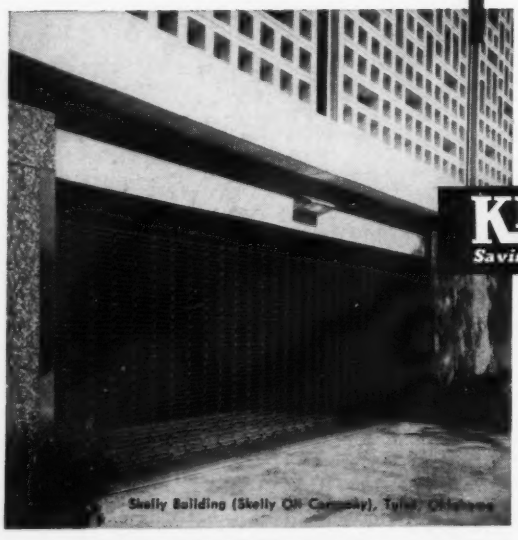

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New Publications

Hydraulic research . . . . A compilation of research conducted in the past year by hydraulic and hydrologic laboratories in the United States and Canada has been issued as National Bureau of Standards Miscellaneous Publication 231. Copies are $1.00 each and may be obtained from the U.S. Government Printing Office, Washington 25, D. C.

Consulting practice . . . . A manual of recommended principles for consulting engineers has been published by the Consulting Engineers Council for use by its member firms. Titled "The Practice of Consulting Engineering," the manual assembles a series of practical guides on the mechanics of conducting a successful engineering practice. Inquiries should be sent to the Consulting Engineers Council, Springfield, Ill.

Highway officials, directory . . . . More than 2,000 names, titles, and addresses of administrative engineers and officials in the fifty state highway departments, the District of Columbia, and Puerto Rico are listed in the 1960 edition of the convenient, pocket-sized directory, "Highway Officials and Engineers," published annually by the ARBA. The directory sells for $1.00, and is available from the American Road Builders' Association, World Center Building, Washington 6, D. C.

Pollution control . . . . Data on 280 water supply and pollution control projects conducted in the U.S. in 1958 are summarized in a publication of the U.S. Public Health Service, entitled "Research Inventory of Active Projects—1958." Free copies of the 71-page booklet may be obtained from the Research Grants Coordinator, Division of Engineering Services, Public Health Service, Washington 25, D. C.

Building research . . . . Publications on building research work carried out from 1947 through 1959 by the National Research Council of Canada and its Division of Building Research are listed in a recent release from the Council. The listing, including prices and directions for ordering, is available on request to the Division of Administration, National Research Council, Ottawa, Canada.

Sewers, maintenance . . . . The latest edition of the Manual of Practice Series issued by the Water Pollution Control Federation provides a comprehensive guide to sewer maintenance. Identified as Manual of Practice No. 7, the 64-page booklet may be ordered from the Water Pollution Control Federation, 4435 Wisconsin Avenue, Washington 16, D. C., at $1.50 a copy postpaid.

Fallout shelters . . . . To provide architects and engineers with procedures and standards for evaluating the fallout shelter potential of existing structures and for modifying these structures to make them more effective as shelters is the purpose of a recent publication of the Office of Civil and Defense Mobilization, entitled "Fallout Shelter Surveys: Guide for Architects and Engineers." Inquiries about the guide, identified as NP-10-2, should be addressed to the Executive Office of the President, Office of Civil and Defense Mobilization, Washington 25, D. C.

Flood protection . . . . A study to estimate the feasibility of flood proofing as a method of reducing flood damage—a cooperative project of the Tennessee Valley Authority and the University of Chicago Department of Geography—has just been released as Research Paper No. 65 of the Department of Geography. John R. Sheaffer is author of the publication, entitled "Flood Proofing: an Element in a Flood Damage Reduction Program." Copies, priced at $4, are available from the University of Chicago Press, Chicago, Ill.

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Forming speed and economy can be greatly increased by crane handling big monoliths of UNI-FORM Panels. Contractors with repetitive section forming requirements are finding that the design of UNI-FORM Panel monoliths—in which metal filler angles are used between each panel—give them greater versatility and wider application. For example . . . tie rods of any size from ½" to 1" may be used to tie two monoliths into a wall form. This permits using the right tie size for the job. Fewer ties are required and sections can be placed, tied and ready for concrete faster. Panels may be added or removed at will to produce any monolith required.

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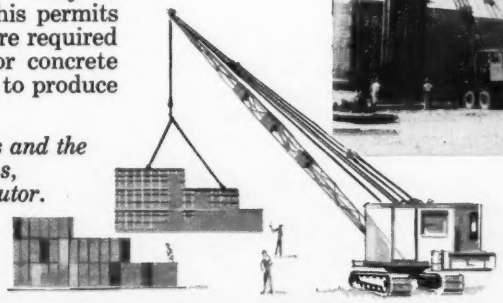

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BRANCH OFFICES and WAREHOUSES:
ATLANTA BALTIMORE CLEVELAND HOUSTON
LOS ANGELES SAN LEANDRO TORONTO

Deceased

(Continued from page 86)

ber 7. Mr. Cleverdon was an engineer with the New York Department of Docks from 1906 until 1917 when he became vice president of Allen N. Spooner, Inc. Two years ago he retired to become consultant to the firm.

Ernest Buchanan Crane (M. '24; F. '59), age 78, retired railway engineer of Seattle, Wash., died in that city recently. He began his professional career in 1906 as resident engineer with the Chicago, Milwaukee, St. Paul and Pacific Railroad Company, and was a principal in the planning and construction of the Tacoma Railway Terminals for the company. He then served in various engineering assignments in the Northwest for the Milwaukee Railroad until 1918, when he became a valuation engineer in the Chicago office. In 1920 he returned to the Pacific Northwest as assistant chief engineer, with headquarters in Seattle, remaining there until his retirement in 1952.

Howard M. Cryder (A.M. '06; M. '59), age 81, former co-owner and operating head of the Carmichael-Cryder Construction Company of St. Louis, Mo., died recently in Van Nuys, Calif. Among Mr. Cryder's design and construction accomplishments are the Broad Street Bridge over the Scioto River in Columbus, Ohio; the Austin, Tex., bridge and dam; two major viaducts over Main Street in Houston; the Kingshighway Viaduct in St. Louis, Mo.; the Hotel Imperial and the Gante Hotel in Mexico City; and the Hotel Raz and the Aguila Oil Company Building in Tampico. He was particularly noted for his design of special earthquake-proof foundation work adaptable to volcanic ash soil in his Mexico City projects, and also for advanced concepts in prestressed concrete work.

Eivind G. Elstad (M. '57; F. '59), age 58, an authority on construction in arctic climates, died in New York City on December 7. A senior partner in the New York City consulting firm of Severud-Elstad-Krueger-Associates, Mr. Elstad was responsible for many projects for which his firm acted as consultant—among them the Thule Air Force Base in Greenland, Tripler General Hospital in Hawaii, and the Seagram Office Building in New York.

Andrew Fischer, Jr. (A.M. '19; M. '59), age 70, who at the time of his retirement last year was chief of construction east of the Mississippi for Charles Luckman Associates, of New York City, died there on November 12. From 1938 to 1946 Mr. Fischer was executive vice president of the James Stewart Company, and from 1946 to 1955, vice president of the Cauldwell-Wingate Company. New York projects on which he worked include the $130 million Chase-Manhattan Bank, the West Side Highway, the Fort Hamilton Veterans Hospital, the Beekman-Downtown Hospital, various housing projects, the Woolworth Building and Madison Square Garden.

Patrick Edward Garner (M. '57; F. '59), age 56, on the engineering staff of Litchfield, Whiting, Panero & Associates, Bangkok, Thailand, died there recently. He had been design engineer for Howard, Needles, Tammen & Bergendorf on four bascule bridges under a contract with the New Jersey State Highway Department; president and chief engineer of the Coastal Corporation; and resident engineer abroad for Knappen-Tibbets-Abbett-McCarthy. In the latter position he was employed from 1954 through 1957 on a multi-purpose concrete dam on a tributary of the Meander in southwestern Turkey and on a multi-purpose rock-fill dam southeast of Ankara, Turkey.

Royce W. Gilbert (M. '52; F. '59), age 73, retired consultant of Umatilla, Fla., died there recently. For most of his professional life Mr. Gilbert maintained his own consulting practice, first in Boston, Mass., and just prior to retiring in Tuckahoe, N. Y. From 1945 to 1950 he was vice president and chief engineer of Sordoni Interests.

Ernest Lee Jahncke (A.M. '07; M. '59), age 83, retired Rear Admiral and former Assistant Secretary of the Navy (1929-1933), died in Pass Christian, Miss., on November 16. An outstanding New Orleans business executive and engineer, he was president of Jahncke Service, Inc., and the Jahncke Dry Dock. In 1927 he was named president of the Reparation Flood Commission, following the disastrous Mississippi River flood of that year. At the time of death he was vice president of the Board of Administrators of his alma mater, Tulane University.

Samuel Thomas Jones, Jr. (A.M. '18; M. '59), age 75, at the time of his retirement in 1954 vice president of the Hardaway Contracting Company in Tullahoma, Tenn., died recently in Birmingham, Ala. Mr. Jones first joined the Hardaway Company as project manager in 1915, advancing to vice president in 1937.

John B. Stein (A.M. '15; M. '59), age 83, retired consulting engineer of Yonkers, N. Y., died there on October 29. For many years prior to his retirement three years ago, he had conducted a civil engineering and consulting concern in his own name in New York City. At one time he was engineer for the Sinclair Oil Company.

Walter C. Voss (A.M. '18; M. '59), age 73, professor emeritus and special lecturer at the Massachusetts Institute of Technology, Cambridge, Mass., died there on November 2. Professor Voss first joined the MIT faculty in 1928 as professor of building construction and twelve years later was named head of the department of building, engineering and construction.

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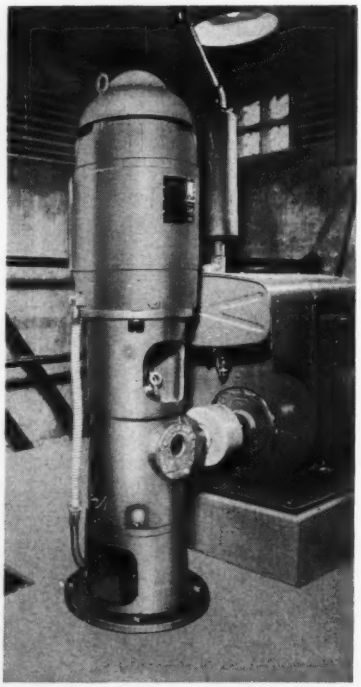

Cross State Development Co. installed the Johnson combination drive shown here in a sewage disposal plant in Florida. They report: "It's recognized as one of most efficient, packaged systems in the Tampa area. We've never experienced any difficulty." Neither will you because Johnson combination drive assures engine take-over the instant electricity fails. Either power unit may be overhauled without interrupting service.

Sizes: 15 to 450 hp. Johnson Right Angle Gear Drives are available in combination, dual and standard types; for all horizontal prime movers; hollow or solid shaft. Please write for engineering catalogs.

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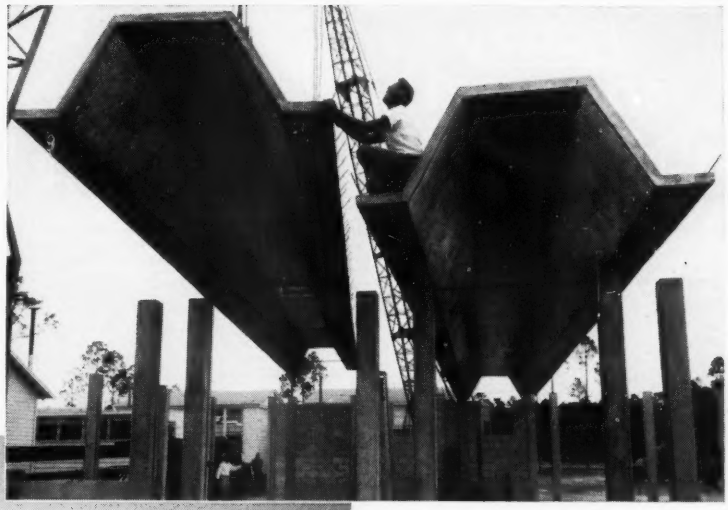
Concrete folded plates in new Florida school



Folded concrete plates were tied to precast columns by welded connections. Cast-in-place concrete between plates made a continuous rigid roof. Columns were anchored to foundations by bolted connections.

There are 90 folded plates. Each is 72′ long 9′ wide and 3″ thick. Depth of plate is 34″. There are 116 precast columns. Each is 9½″ x 9½″ x 11′-0″. The total roof area is approximately 60,000 sq. ft. covering 40 classrooms and additional special rooms.

. . . FUNCTIONAL, ECONOMICAL, APPEALING

Precast concrete folded plates gave the State of Florida something new in school construction. The simplicity of this pleasing geometric concrete design made it possible to complete the project in the 10 months allowed and to stay within the school district budget. The result is a sturdy fireproof structure for some 600 pupils, that will require little or no maintenance.

In the manufacture of the precast folded plates and supporting columns, Concrete Structures, Inc. used Lehigh Early Strength Cement for maximum production efficiency. Units were removed and forms were ready for reuse in less than half the time required with normal cement.

For modern concrete construction, either precast or cast-in-place, chances are Lehigh Early Strength Cement can save you time and money. Lehigh Portland Cement Company, Allentown, Pa.

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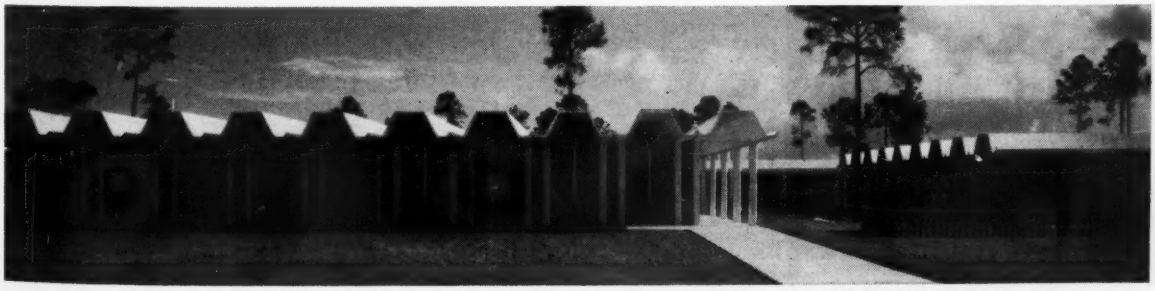
Architects: Robert B. Browne
George F. Reed, Associate
Design Engineer: Walter C. Harry
Consulting Engineer: H. J. Ross Associates
Contractor: Stobs Brothers Construction Co.
All of Miami, Florida
Precast Concrete: Concrete Structures, Inc., North Miami, Florida

LEHIGH CEMENTS



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Recent Books

(Continued from page 90)

and planned reactors is appended with a historical survey of the field and an extensive bibliography. (By Karl Rudolf Schmidt. Walter de Gruyter & Co., Berlin, Germany, 1960. 1,336 pp., bound.)

Off-the-Road Locomotion

General in treatment, this book serves as an addendum to the author's "Theory of Land Locomotion" (1956), in discussing subsequent developments and outlining the present state of the art of terramechanics". Here, the author describes recent important developments in industry and education, discusses soil and snow mechanics, tracks, wheels, tires and the making of predictions of vehicle performance and design parameters, all relevant to the vehicle treated as a unit in physical relationship to the soil over which it moves—other than the conventional roads and highways. (By M. G. Bekker. The University of Michigan Press, Ann Arbor, Mich., 1960. 220 pp., bound. $10.00.)

Papers on Soil, 1959 Meetings

Includes 29 papers presented at four separate sessions of the 62nd annual meeting and the 3rd Pacific Area Meeting, ASTM, during 1959. Strain-rate effects, consolidation of clays and soils, repeated loading measurements, and a literature survey 1846-1958 on dynamic resistance of cohesive soils, are considered in 8 papers from the Symposium on Time Rates of Loading. Nine papers from the Symposium on Atterberg Limits discuss manifold aspects of the various Atterberg Limits tests. Three papers presented at the Session on Soils cover laboratory and field tests on granular materials, application of lime for soil stabilization, and the preconsolidation of a sensitive clay. The remaining nine papers were presented at the Symposium on Soils for Engineering purposes, and cover problems related to soil density, moisture content, load and compression testing and a proposed classification system for soils. (Published as ASTM Special Technical Publications No. 254 by the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 1960. 375 pp., bound. $9.00.)

Regions, Resources, and Economic Growth

This study describes U. S. natural resources activities—farming, fishing, forestry and mining, and the processing of their products—within the broad framework of over-all national, and differential regional, economic growth, to elucidate the complicated interrelationships between economic growth and use of natural resources. The five sections of the book deal with regional economic growth and development 1870-1950, a framework for analysis of economic growth, regional distribution of economic activities 1939-1954, and variations in levels and rates of growth per capita income. Extensive tables accompany each section. (By Harvey S. Perloff and others. The Johns Hopkins Press, Homewood, Baltimore 18, Md., 1960. 716 pp., bound. $12.00.)

Reinforced Concrete Column Tables

Prepared for practising structural engineers, architects, and designers, these tables are arranged in two groups—rectangular tied columns, covering 63 sizes, and spirally reinforced round columns, covering 12 sizes. Special features include the extreme range of values for each column design, the wide range of rectangular column sizes, and the inclusion of values for eccentrically loaded columns both with reinforcing on all four faces and with extra reinforcing on the tension face alone. (By Hugh F. Fenlon. Distributed by F. W. Dodge Corporation, 119 West 40th Street, New York 18, N. Y., 1960. Various pagings, bound. $15.00.)

Soil Engineering
Second Edition

With a notable foreword by Karl Terzaghi, this is a practical introduction of the subject on the undergraduate level. It describes the origin, properties and classification of soils, all aspects of water, frost, and stress distribution in soil, and soil practice in connection with dams and levees, retaining walls, underground conduits, piles and pile-driving, and the consolidation and settlement of structures. This new edition incorporates improvements and additions reflecting advances in the science since 1951. (By Merlin Grant Spangler. International Textbook Company, Scranton 15, Pa., 1960. 483 pp., bound.)

Stresses in Shells

Written for practising engineers and research workers, this book contains a unified presentation of the basic facts of shell theory, and solutions in sufficient detail to make them readily applicable to design work. The level of the mathematical tools employed has been kept as low as compatible with the needs of the subject matter. Familiarity with linear differential equations is necessary, and with partial differential equations would be useful. Chapter one contains introductory matter, chapters 2-4 cover membrane theory, chapters 5-6 are devoted to the bending theory of the circular cylinder and the general shell of revolution, and the final chapter is concerned with the stability of shells. The appendix contains a compilation of formulas concerning forces and deformations in circular rings. (By Wilhelm Flügge. Springer-Verlag, Berlin, Germany, 1960. 499 pp., bound. DM 58.80.)

Library Services

Engineering Societies Library books, except bibliographies, handbooks, and other reference publications, may be borrowed by mail by ASCE members for a small handling charge. The library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any items in its collection. Address inquiries to R. H. Phelps, Director, Engineering Societies Library, 29 West 39th Street, New York 18, N. Y.

Symposium on Air Pollution Control

At the Third Pacific Area National Meeting of the ASTM in San Francisco, October, 1959, the following papers were presented and here are published:—Air pollution potential of California coastal climate; Wind and weather summaries for chemical plant design and air pollution control; Fluorescent dyes as airborne trace materials; Colorimetric determination of formaldehyde and methanol from combustion source; Determination of gaseous and particulate inorganic fluorides in the atmosphere. (Published as ASTM Special Technical Publication no. 281, by the American Society of Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 1960. 44 pp., bound. $1.50.)

Symposium on Durability and Weathering of Structural Sandwich Construction

The seven papers presented at the Symposium deal with: the effect of normal aging on strength of glass-fiber reinforced-plastic honeycomb cores; effect of natural environment on sandwich structure with AMS 3722 paper honeycomb-core; effect of environment exposure on adhesive-bonded structures; experience with sandwich construction in aircraft applications; temperature rise in structures due to solar heating; effect of climatic variations on polystyrene foam-core sandwich panels in roofs and walls; and experiences with structural sandwich in building construction. (Published as ASTM Special Technical Publication No. 270, by The American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 1960. 71 pp., bound. $3.00.)

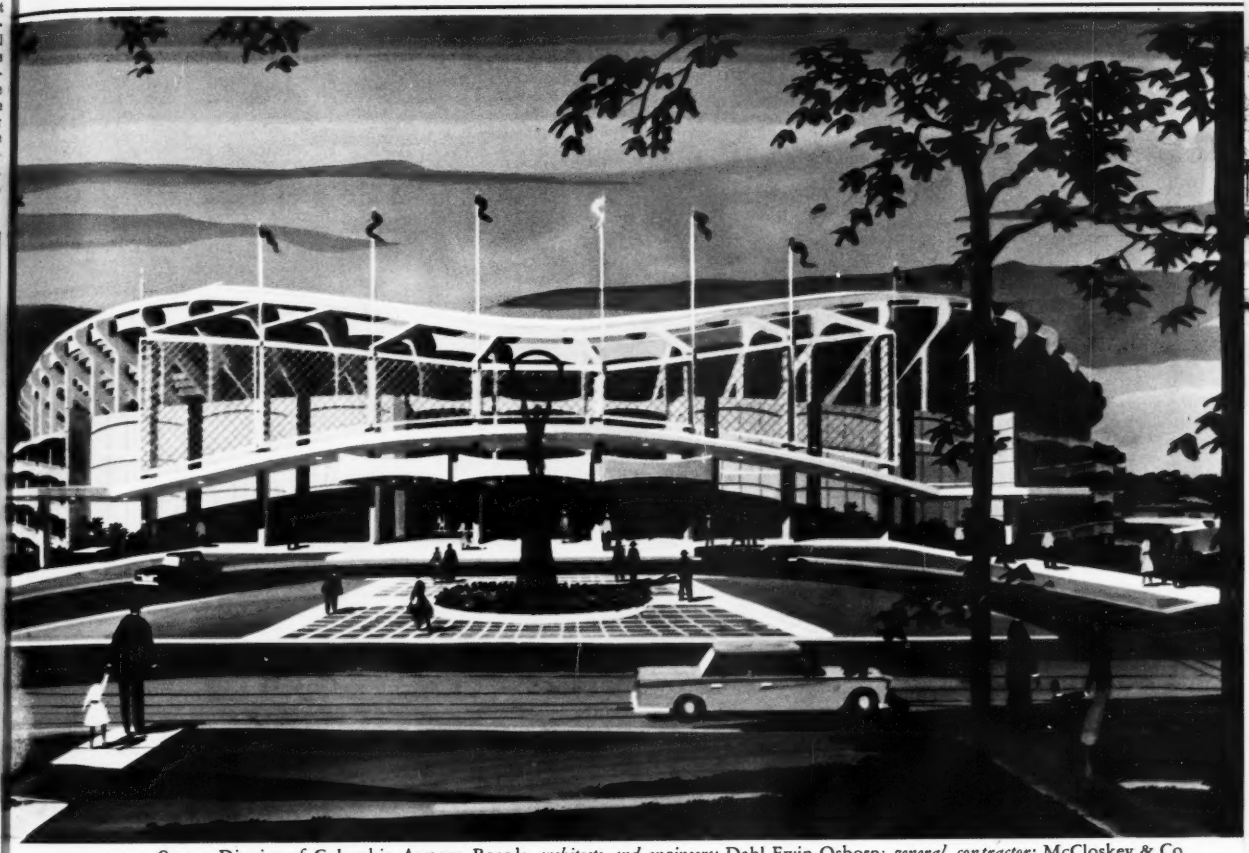
Ultimate Moments and Shears in Continuous Reinforced Concrete Beams

This monograph considers the development of ultimate moments and shears in continuous reinforced concrete beams under loads producing conditions of structural collapse. Part A discusses the relationships of a purely theoretical character, and Part B all experimental results from tests, with comparisons to theory. The theory is restricted to the particular loading conditions of the tests, but can be extended to other conditions of loading and to other structures. (By George C. Ernst. The University of Michigan Press, Ann Arbor, Mich., 1960. 37 pp., bound. $4.00.)

JANUARY 1961

Progress Report on STEEL CONSTRUCTION

BETHLEHEM STEEL COMPANY



Owner: District of Columbia Armory Board; *architects and engineers:* Dahl-Ewin-Osborn; *general contractor:* McCloskey & Co.

The Capital Gets A Remarkable Stadium

The undulating roof line shown in this architectural rendering suggests that here is a stadium not quite like any other. And such is indeed the case. It is unusual in that it is circular in plan, and double-decked all the way around. Although the seats are roofed over, there are no supporting columns to obstruct vision. And about 340 ft of the lower stands are movable in two sections, to accommodate the differing requirements for viewing football and baseball games. Seating capacity for the gridiron sport is approximately 50,000, and 43,500 for baseball games.

The upper decks and roof are supported by pin-mounted welded steel rigid frames of box section. There are 66 of these frames, laterally connected by a combination of box struts and WF rafters, totalling some 7,350 tons of steel. These frames support the seating and roofing on cantilever arms as long as 80 ft!

Most connections will be field welded, and lifts require the use of a stiffleg derrick mounted on a traveler with an 85-ft-high tower, as well as a crawler crane.

The total price tag comes to about $15,000,000 for the structure, plus its landscaping, parking areas, and an access road. It is hoped that the project will be ready for the kick-off of football season—Bethlehem began steel erection this month.

Project development by Atlas Terminals, Inc.; *architect:* Charles Luckman Associates; *structural engineer:* James Ruderman; *associate structural engineer:* Henry Layne; *mechanical engineer:* Cosentini Associates; *general contractor:* Haas & Haynie.

A Whopper for Wilshire

Since the removal of the height limit restrictions, buildings in Los Angeles have edged upward. And this one beats them all—it's the Pacific Tower, 300 ft high, with 26 office floors comprising some 280,000 sq ft of floor area. Upon completion it will be the tallest commercial building in Southern California.

At its base, and emphasizing the dramatic height of the tower, are a four-story office building, a four-story parking structure, and *space*—about 35 per cent of the site area is open to light and air. The handling of this open space and its relationship with the structures around it represent a substantial civic contribution by the owners and designers. They have publicly expressed their hope that the $10-million project, first major new construction on this portion of Wilshire Boulevard, will establish a high standard of public responsibility for others yet to come.

The tower, fronting on Wilshire at McCarthy Vista and Warner Drive, will be framed with about 2,110 tons of structural steel. A steel-framed three-level bridge will connect the tower with the adjoining low-rise office structure. Fabrication of steelwork is being handled at Bethlehem's nearby Torrance Works.

Bethlehem Builds for the Future

With general headquarters virtually bursting at the seams, Bethlehem Steel's office planners looked across the Lehigh River, to the north side of the city, for badly needed office space. There the company is now putting up this handsome, U-shaped office structure, measuring approximately 356 ft by 337 ft in plan. Its two office floors will initially accommodate more than 1,000 employees, including fabricated steel construction, accounting, and records administration personnel. There will be ample space for additional personnel to meet future requirements.

The new facility is planned to be a virtual showplace of construction products made of Bethlehem steel. The framework will be of structural steel, with field-bolted joints. Curtain walls feature porcelain-enameled sheets of Bethnamel, the company's newly developed enameling steel. Floors are poured concrete on cellular steel sub-flooring, while the built-up roof will be applied to steel roof decking.

The view from the $3.5 million-plus building will include the company's tremendous research laboratories complex on the crest of South Mountain, a $25-million investment in basic and applied research and development, and one of the nation's largest privately financed research facilities.

Architect: McKim, Mead & White; *general contractors:* McCloskey & Co.

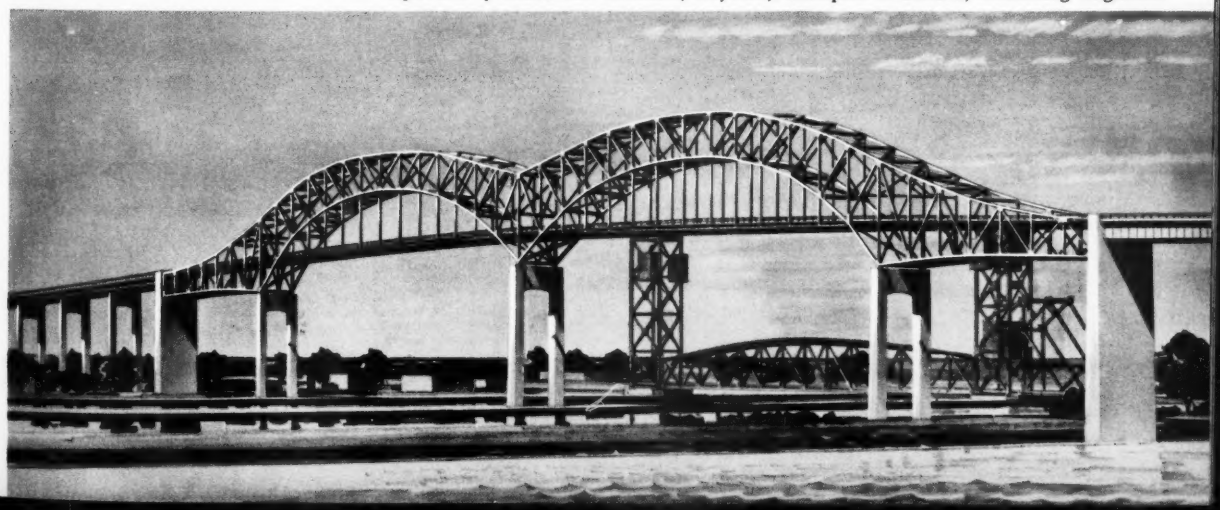
A New International Bridge

Work has begun on a major crossing that will provide another much-needed link between the United States and its good neighbor to the North. The bridge will pick up traffic from Interstate 75, the high-speed highway extending from the Michigan-Ohio boundary northward, across the Straits of Mackinac and into the town of Sault Ste. Marie. On the other side of the border through traffic will proceed into Ontario by King's Highway 17.

The over-all crossing totals 14,595 ft in length, including plazas, and provides a 28-ft, two-lane roadway. It includes a variety of structures. Bethlehem Steel has the superstructure contract for the continuous-truss bridge shown in the rendering, plus adjacent 3-span and 4-span continuous deck-plate-girder units to the north. Total length of the contract is 2,663 ft.

The main bridge, of continuous, double arched-truss design, totals 1,260 ft in length, crossing the American and Canadian Ship Canals with clearance of 124 ft above low water. It has 200-ft end spans, and two 430-ft main spans. Steel required is approximately 3,900 tons.

Owner: The International Bridge Authority of Michigan; *design engineer:* the late D. B. Steinman; *supervision of construction:* Steinman, Boynton, Gronquist & London, Consulting Engineers.



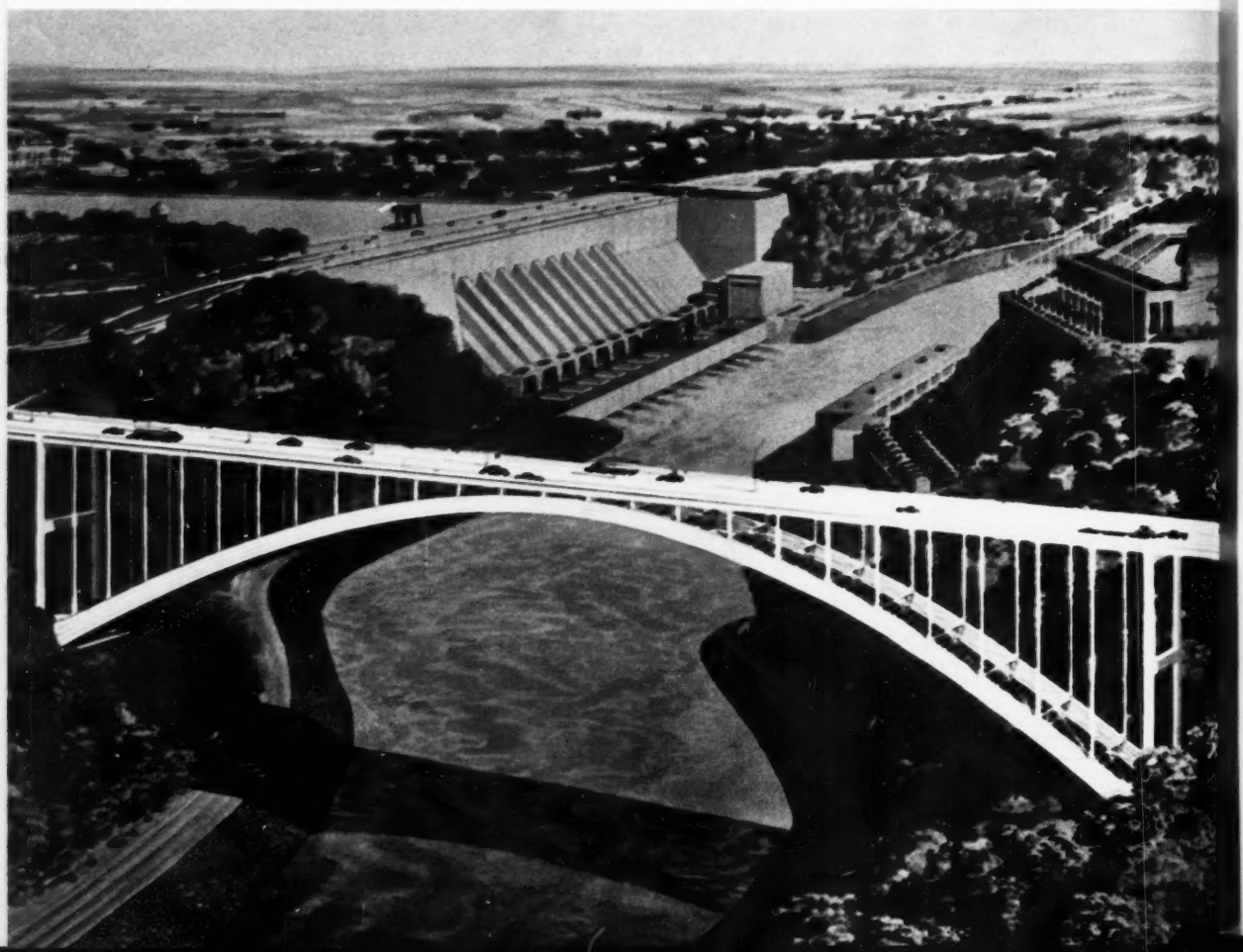
BETHLEHEM STEEL

Bridging a Friendly Border

In October 1960, Bethlehem was awarded the superstructure contract for this graceful arch bridge over the Niagara River between Lewiston, N. Y. (at left) and Queenston, Ontario, six miles downstream from Niagara Falls. Its main span of 1,000 ft will make it the world's seventh longest arch span, and just 50 ft longer than the famous Rainbow Bridge, completed by Bethlehem in 1941. Its roadway will carry motorists some 370 ft above the turbulent waters.

Cost of the project, exclusive of extensive approach work, will be $6.5 million—about $1.4 million *under* the engineer's estimates.

Owner: Niagara Falls Bridge Commission; *consulting engineers:* Hardesty & Hanover; *contractors for substructure and approaches:* Bates & Rogers Construction Corporation (American side); Steed & Evans Limited (Canadian side).



Architect: Maurice Fletcher; *structural engineer:* Kneas & Long; *general contractor:* McCloskey & Co.

Bell Tel Consolidates in Philadelphia

This elegant structure, sheathed in bronze and stainless steel, will soon rise in Philadelphia's resurgent central-city area. It's to be located on Arch Street at Sixteenth and Benjamin Franklin Parkway. There it will bring together about 2,500 employees of Bell Telephone Company of Pennsylvania's home office and area headquarters, who are presently quartered in nine separate locations.

It's a big building, rising 258 ft to the roof of the two-story equipment penthouse that tops the eighteen office floors. Total floor area is nearly 500,000 sq ft, with 378,000 sq ft of net usable office space. Three factors increase the usable space per floor: first, the structural steel columns are located *outside* the building's peripheral walls; second, the central core design eliminates wasted corridor space; third, the use of slim, space-saving stainless steel exterior wall construction.

Sure to evoke much favorable comment are the moat-like pools along Arch Street. Tile-bottomed, and eighteen inches deep, they will reflect the structure's gleaming facade. A "bridge" provides access to the main entrance.

Bethlehem's erection crews will use high-strength structural bolts, making this the city's biggest bolted structure. Total steel requirement is 4,400 tons, fabricated at our Bethlehem, Pa., works.

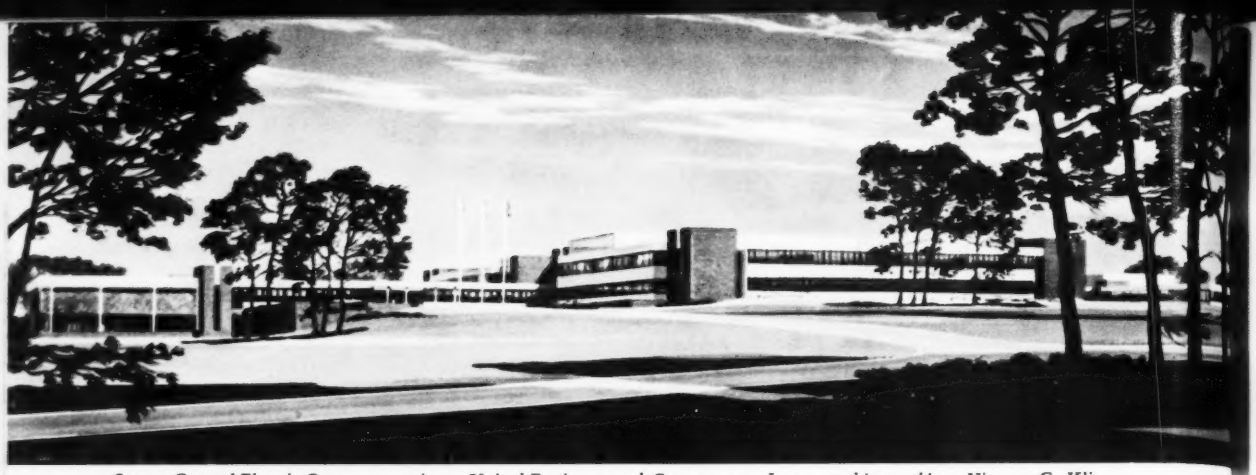
New York State's $100-Million Campus

It's not a university—it's the headquarters of New York State government in Albany. Conceived ten years ago, the far-reaching plan will consolidate scattered offices in new efficient buildings on a campus-like site.

In mid-1960, Governor Rockefeller announced a "sharp acceleration" of the program to complete construction of the vast project. As a result, well over $50 million in contracts for office construction and access highway work is underway or scheduled for the fiscal year. And there's much more to come. The Governor pointed out that the facilities will not only save tax money by increasing the operating efficiency of state departments, but the construction work itself will be a healthy stimulus to the economy.

Of the 22 buildings planned, two are those housing the departments of Conservation and Civil Service. Both have steel frames fabricated by Bethlehem. Nearing completion is the power house (Bldg. 5), and work is underway on the Department of Public Works building (Bldg. 19), both of which have Bethlehem frameworks founded on deep-driven Bethlehem H-Piling.

Architect: Office of the State Architect; *general contractor for the Civil Service and Conservation buildings:* Brown-Turner Inc.; *for Bldg. 5 and 19:* Depot Construction Corp.; *foundation contractor:* Western Foundation Co.



Owner: General Electric Company; *engineers:* United Engineers and Constructors, Inc.; *consulting architect:* Vincent G. Kling

$14,000,000 For Space Research

Historic Valley Forge is becoming closely allied with vital developments of the space age. The reason lies in the significance of construction work in progress at the junction of the Pennsylvania Turnpike and Schuylkill Expressway, just 17 miles west of Philadelphia. There General Electric Company is building a $14-million space center—more properly, the Missile and Space Vehicle Department's research and development laboratories.

The new MSVD facility, located on a 130-acre tract, will eventually employ upwards of 5,000 persons, including as many as 1,200 or 1,400 engineers and scientists—one of the biggest concentrations of such highly trained personnel in the entire land.

The first phase of work (which includes construction of a headquarters building, the Space Sciences Laboratory, and an engineering and development facility) is scheduled for completion late in 1961. The second phase, to begin in 1962, will add facilities for development manufacturing, quality control, acceptance testing, and product design, and will be completed no later than 1963.

Bethlehem has contracted to furnish the steelwork for a major portion of the construction now underway. What appears here to be a single sprawling building actually comprises a number of interconnected buildings. Construction is conventional steel beam-and-column, generally with 24-ft-square bays, and topped with steel roof decking over Bethlehem's open-web joists. The steel erectors will use Bethlehem structural bolts.

Owner-Designer: State of Oregon, Dept. of Highways; *general contractor:* Bethlehem Steel Company, Pacific Coast Div.

Straightening Out U. S. 101

Everyone in the Far West knows Route 101. It's the coastal highway that skirts the Pacific from Juan de Fuca Strait clear down to the Mexican border. Shorelines being what they are, the highway makes many a twist and turn on its 1,600-mile jaunt. One of these is a few miles north of Brookings, in the extreme southwest corner of Oregon.

There a small stream known as Thomas Creek has cut a deep ravine, and 330 ft over it, 957 ft from abutment to abutment, the Department of Highways is constructing a two-lane highway bridge. It is of continuous deck-truss design, supported on two 300-ft-high towers. All members are to be made up of welded plates of ASTM A373 (carbon C) or ASTM A-242 (low-alloy A). Field connections will be made with high-strength structural bolts.

Bethlehem's erection scheme calls for use of a guy derrick to construct the south tower, while a stiffleg derrick traveler erects the roadway from the south approach out over falsework bents. After the roadway lands on the south tower, the center span will be cantilevered out 160 ft to the north tower.

Making Gowanus Grow

The Gowanus Expressway in Brooklyn is already a heavily traveled mid-city elevated highway—but it has a much bigger job ahead. It will be one of three major arteries feeding into the now-abuilding Verrazano-Narrows Bridge, and as such must be capable of handling vastly increased traffic loads, especially as it will be the main connection between the bridge's eastern end and the Brooklyn-Queens Expressway which, in turn, feeds into the river crossings to Manhattan and leads to the Long Island Expressway serving all of Long Island. Total cost of converting the highway to meet the new needs, in accordance with Federal Interstate standards, is estimated at $81 million.

At present the expressway is a narrow, four-lane elevated parkway in Third Avenue. The structure extending from 38th Street to 65th Street was originally an elevated railway, later converted to motor traffic. However, it is totally inadequate to handle the increasing traffic burden, and suffers from the additional limitation of being restricted to passenger-car traffic. The new artery will also serve commercial vehicles.

Conversion of this portion of the parkway to a broad, six-lane elevated highway is a job Bethlehem will be handling in 1961. The over-all project has widened the Third Avenue right-of-way from 80 ft to 180 ft. In order to interfere with normal traffic flow as little as possible, Bethlehem will erect both lines of columns, the center portion of the roadway, and one of the roadway "wings" adjacent to the existing structure, which will remain in operation. Then traffic will be directed onto the four new lanes, while the old el is demolished. Finally the other new "wing" will be added.

The new elevated structure will total 94½ ft in width, providing six traffic lanes in two 38-ft roadways plus a 13-ft median strip with turn-off for disabled vehicles.

Bethlehem's contract, which extends from 36th to 53rd Street, requires about 12,500 tons of fabricated and erected structural steel, as well as large tonnages of concrete reinforcing bars.

Owner: State of New York, Department of Public Works; *consulting engineers:* Madigan-Hyland; *general contractor:* Slattery Contracting Company

Late News Flashes

BRONX, N. Y.--In early '61, Bethlehem will begin erecting nearly 12,000 tons of steel for a 57-span, 4,118-ft-long, 6-lane section of Bruckner Expressway. Bethlehem is also supplying piling and reinforcing bars to Gull Contracting Company, Inc., holder of the $10.5-million Contract 3 of Section 1 of this important phase of New York City's system of Interstate highways.

NEW YORK CITY--Fisher Brothers, one of the city's largest real estate and construction firms, has announced plans to erect a 44-story office building on Third Avenue between 39th and 40th Streets. Bethlehem will put up the 9,000-ton steel framework for the striking and completely modern structure.

DOYLESTOWN, PA.--Bucks County, famous for its many venerable colonial buildings, will soon be noted for one of the nation's more unusual public buildings. It's to be a circular court house building, 156 ft in diameter, five stories high. It requires about 700 tons of steel, to be fabricated by Bethlehem.

JOHNSTOWN, PA.--Pennsylvania Electric Company, a subsidary of General Public Utilities and one of the state's biggest utilities, is constructing a handsome new system headquarters building, along with sizable service and storage facilities. The 220-ft-long, four-story office building (plus a two-story wing) boasts an open, 25-ft-wide arcade at ground level running along the entire front elevation, giving the building the appearance of being partially supported on stilts. Bethlehem is supplying the structural steelwork.

HARTFORD, CONN.--Work is well underway here on Constitution Plaza, one of the nation's biggest--and perhaps the most spectacular--urban redevelopment projects. Among the ten or so structures being constructed on the 15-acre site are two office buildings, 18 and 20 stories in height, for which Bethlehem is supplying the steelwork. The owner-developer is F. H. McGraw & Company.

SOMERSET, MASS.--$80 million is the price tag for New England Electric System's Brayton Point Power Station, on the Taunton River opposite Fall River. The first 250,000-kw unit is slated for completion in 1963. And that's just the beginning. A second unit of equal size will go on line a year later, and three additional units are planned for an ultimate output of 1,000,000 kw. When both units are in operation, the station will be the largest single generating plant in the System. In summer of 1961 Bethlehem erection crews will begin putting up the 5,600-ton structural frame, using high-strength bolts. Stone & Webster Engineering Company is handling engineering jointly with the System's engineering staff.

PALMERTON, PA.--Work has already begun on one of the nation's most unusual highway structures, a northbound two-lane roadway cantilevered on steel beams over the southbound lane for a distance of about 1,200 feet. Reason is the extremely narrow right-of-way through steep-walled Lehigh Gap. Bethlehem is fabricating the steelwork for the general contractor, J. Robert Bazley.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Sales: Bethlehem Steel Export Corporation

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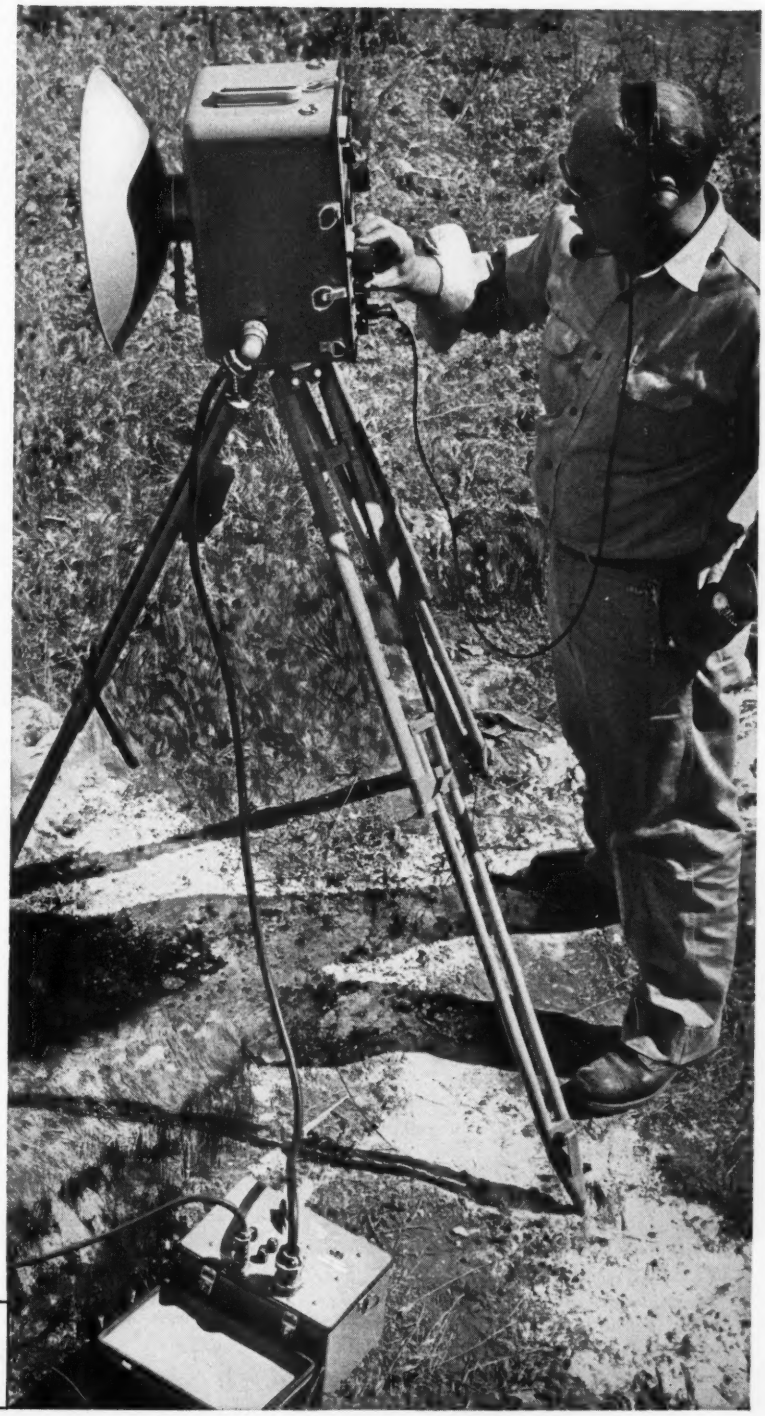

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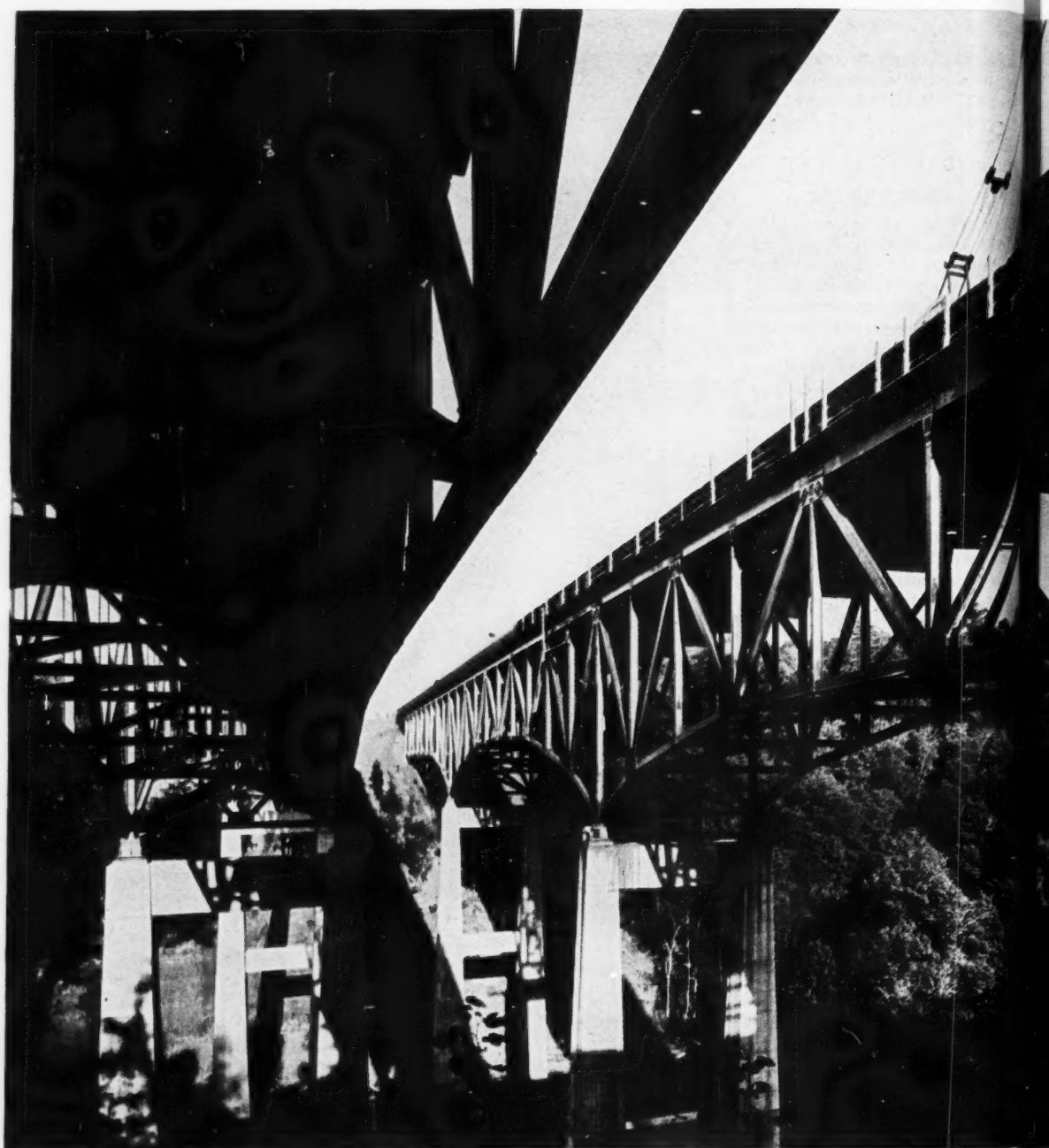
On Erie Thruway twin bridges—

USS MAN-TEN High Strength Steel



USS MAN-TEN Brand High Strength Steel was used for the highly stressed members of these two bridges, including many of the upper and lower chords, diagonals, verticals and gusset plates. Bridge owner: Pennsylvania Department of Highways. Designer: Richardson, Gordon & Associates, Pittsburgh. General Contractor: Brayman Construction Co., Pittsburgh. Erector and Fabricator: The Levinson Steel Co., Pittsburgh.

el saves weight and cuts costs

The use of high strength steel as a means of saving weight and reducing costs in bridges is rapidly gaining favor. These twin bridges across Six Mile Creek on the Erie Thruway, 15 miles east of Erie, Pennsylvania, were built with 600 tons of USS MAN-TEN Brand High Strength Steel to ASTM specification A-440 and 1,200 tons of ASTM A-7 Steel.

High strength steel was used for heavily stressed members where its higher allowable stress value and weight savings made it more economical. The design stress in bridges for USS MAN-TEN Steel is usually 24,000 psi compared to 18,000 psi for ASTM A-7 Steel. The members shown in color in the diagram were made of USS MAN-TEN High Strength Steel. In addition, many of the gusset plates were MAN-TEN Steel.

Weight savings: USS MAN-TEN (A-440) Steel fully meets all the requirements of the new ASTM specification A-440. When full advantage of its higher yield point—50% greater than structural carbon steel—is utilized, it allows the engineer to design with smaller sections than would be normally used—and thereby realize weight savings up to 25%. A cost savings is also possible, since anywhere USS MAN-TEN Steel accomplishes a weight reduction over 16%, it then becomes the more economical steel to use.

Other USS High Strength Steels available for construction include USS TRI-TEN and USS COR-TEN Steels. Like USS MAN-TEN Steel, these grades have a minimum yield point of 50,000 psi and offer the same weight and a potential cost savings. USS TRI-TEN Steel particularly is recommended for welded structures, while USS COR-TEN Steel, because of its outstanding resistance to atmospheric corrosion and superior paint adherence qualities, is a "natural" for bolted or riveted structures where maintenance is a problem.

Where an extra high yield strength steel is needed, USS "T-1" Constructional Alloy Steel combines weldability and toughness with 100,000 psi minimum yield strength.

For complete information on any of these steels, write United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

USS Steels for Bridge Design

Structural Carbon Steel 33,000 psi minimum yield point	**USS MAN-TEN High Strength Steel** 50,000 psi minimum yield point
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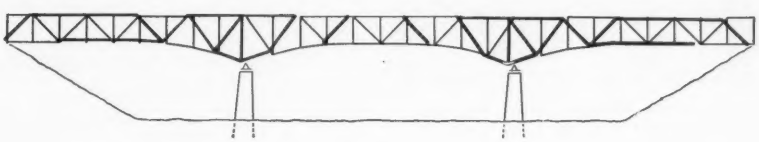

Where high strength steel saved money. Profile of one of the two bridges showing members made of USS MAN-TEN Steel where its high strength/weight ratio made it economical to use.

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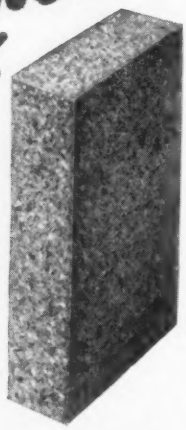

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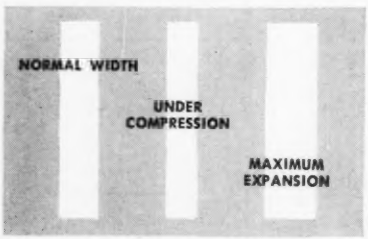

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RUSSELL EDWARD MAHER, New York, N. Y.
DRAGOSLAV SVETOZARA MARJANOVIC, Baltimore, Md.
ROBERT ARTHUR NIELSEN, Des Moines, Iowa
MANUBHAI KASANJI PATEL, Ann Arbor, Mich.
ROBERT CONRAD PAYETTE, Madera, Calif.
JOSEPH WILLIAM PENDERGAST, Santa Ana, Calif.
RAYMOND PRIETO, Hialeah, Fla.
ALI AKHTAR QURAISHI, College Station, Texas
JAMES RICHARD RAKOW, Elgin, Ill.
CHARLES HOLLEY RATHS, Toledo, Ohio
GLENN ELDO RHODES, Decatur, Ill.
KRISHAN KUMAR SAIGAL, Cleveland, Ohio
ELIE ANTOINE SEHNAOUI, Boston, Mass.
PIYUSH CHANDRA SHARMA, East Lansing, Mich.
TARIQ MAHMOOD SHEIKH, Rawalpindi, West Pakistan
WILLIAM WAGNER SMITH, Detroit, Mich.
JAMES POSGATE STEVENS, Mexico City, Mexico
JOHN FALLON SULLIVAN, JR., Helena, Mont.
JAN BASTIAAN VENEMA, Paramaribo, Suriname, South America
HENRY LESLIE WHITE, Sacramento, Calif.
JACK H. WYATT, Sacramento, Calif.
RAYMOND YIH, Serangoon Garden, Singapore
NOBUHIRO YOTSUKURA, Fort Collins, Colo.
GARLAND EDWARD YOUNG, Fort Worth, Texas
NATHAN KIRBY YOUNG, Nashville, Tenn.
JOSE JESUS ZAMORA, Boulder, Colo.

[Applications for the grade of Associate Membership from ASCE Student Chapter Members are not listed.]

Non-ASCE Meetings

American Concrete Institute. Fifty-seventh annual convention at the Chase-Park Plaza Hotel, St. Louis, Mo., February 20-23.

American Institute of Chemical Engineers. National meeting at the Roosevelt Hotel, New Orleans, La., February 26-March 1.

American Institute of Electrical Engineers. Winter general meeting at the Statler-Hilton Hotel, New York, N. Y., January 29-February 3.

Associated General Contractors of America. Annual meeting at the Statler-Hilton Hotel, Boston, Mass., February 27-March 2.

Conference on the Mechanics of Soil-Vehicle Systems. First international conference at the Turin Institute of Technology, Turin, Italy, June 1961.

Highway Geology Symposium. Twelfth annual symposium on geology as applied to highway engineering at the University of Tennessee, Knoxville, Tenn., February 10.

Institute of Transportation and Traffic Engineering, University of California. Thirteenth annual street and highway conference on the University's Berkeley campus, January 26-28.

Instrument Society of America. Annual symposium on "Temperature, Its Measurement and Control in Science and Industry," co-sponsored by the American Institute of Physics and the National Bureau of Standards in Columbus, Ohio, March 27-31.

National Bituminous Concrete Association. Sixth annual meeting at the Shamrock Hotel, Houston, Texas, January 30-February 2.

National Concrete Contractors Association. Annual convention at the Diplomat Hotel, Hollywood, Fla., January 18-20.

National Society of Professional Engineers. Winter meeting at the Hotel Fort Des Moines, Des Moines, Iowa, February 9-11.

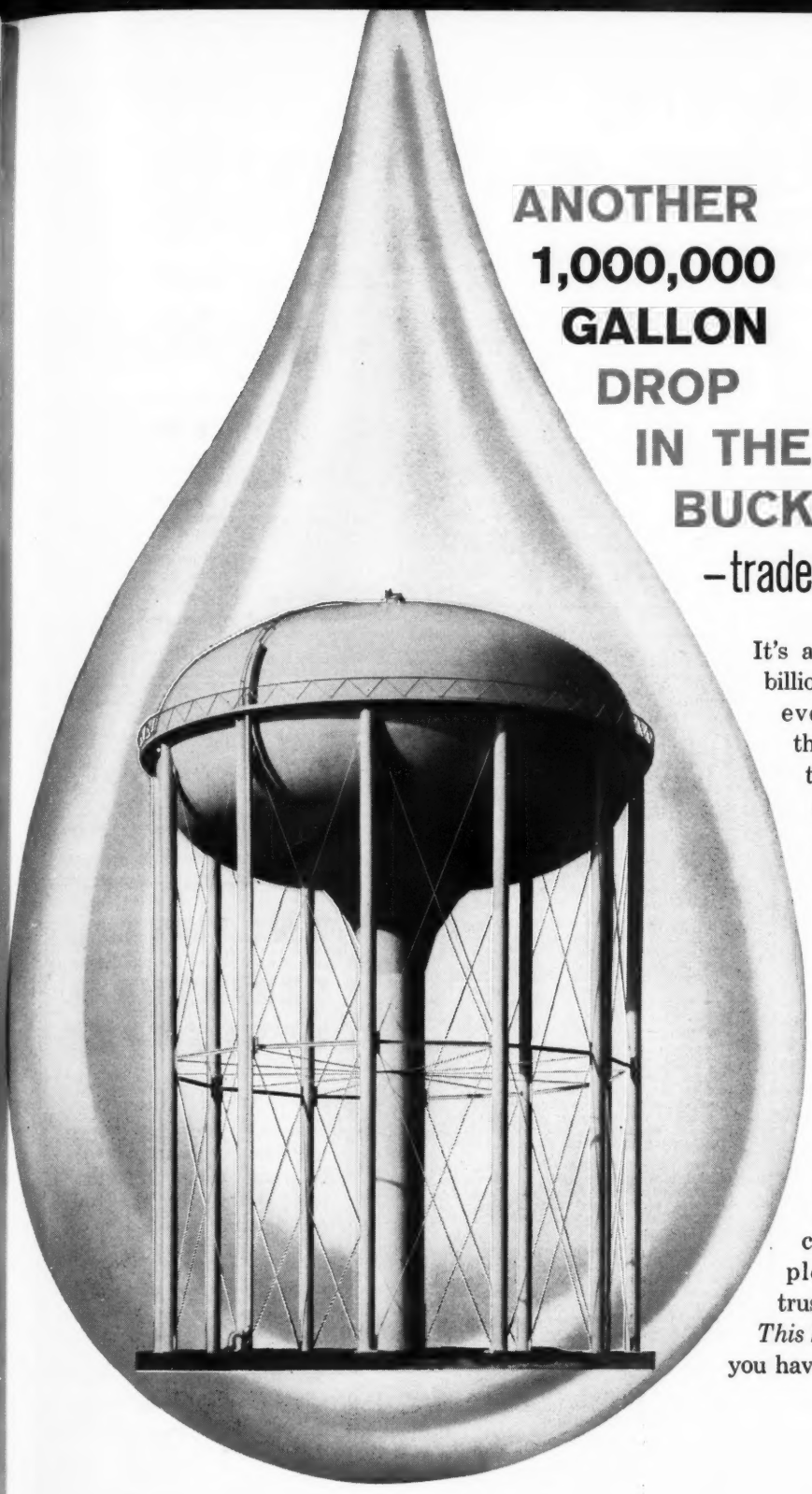
National Ready Mixed Concrete Association. Annual meeting at the Americana Hotel, Miami Beach, Fla., January 21.

Society of Plastics Engineers, Inc. Seventeenth annual technical conference at the Shoreham Hotel, Washington, D.C., January 24-27.

Traffic Institute, Northwestern University. Eighth annual traffic engineering seminar at the Institute, Evanston, Ill., March 6-24.

University of Illinois. Third sanitary engineering conference on disinfection and chemical oxidation in water and waste treatment, sponsored jointly by the Department of Civil Engineering and the Division of Sanitary Engineering of the Illinois Department of Public Health on the University's campus at Urbana, Ill., January 31 and February 1.

University of North Carolina. Seventh annual radiological health seminar, sponsored jointly by the School of Public Health and the North Carolina State Board of Health, on the University's campus at Chapel Hill, N.C., January 30-31.



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ENGINEERING SOCIETIES PERSONNEL SERVICES, INC.

(AGENCY)

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These items are listings of the Engineering Societies Personnel Service, Inc. This Service, which cooperates with the national societies of Civil, Chemical, Electrical, Mechanical and Mining, Metallurgical and Petroleum Engineers, is available to all engineers, members or non-members, and is run on a nonprofit basis.

If you are interested in any of these listings, and are not registered, you may apply by letter or resume and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular placement fee. Upon receipt of your application a copy of our placement fee agreement, which you agree to sign and return immediately, will be mailed to you by our office. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application.

Men Available

ARCHITECTURAL-CONSTRUCTION SUPERINTENDENT, A.M. ASCE, B.S.C.E. Able to assume complete charge of construction. Experienced in multi-story apartments, garden apartments, houses, schools and hospitals. Some experience bidding and estimating. Salary, $10,400. Prefer Philadelphia, Pa. C-631.

CIVIL ENGINEER, J.M. ASCE, B.C.E. Three years' with consultant on highway geometry, alignment and drainage, subdivision design, paving and drainage. One year with contractor, construction superintendent-storm drainage, sewers and treatment plants. Salary, $7,000. Prefer St. Petersburg, Fla., or Overseas. C-633.

CIVIL OR SANITARY ENGINEER, A.M. ASCE, B.S.C.E. Four years' experience with small consulting firm. Seeks position with consulting or contracting firm. Salary, $6800. C-634.

ASSISTANT OR ASSOCIATE PROFESSOR, M. ASCE, Ph.D. Experience includes 15 months of half-time research, two and a half years of consulting, five years of teaching. Salary, $9,000. Prefer East., Midwest. C-635.

ENGINEER MANAGER, B.S.C.E., M. ASCE, P.E., 33. Desires management career opportunity with growth potential. To date experience includes seven years of responsible field engineering, construction supervision, structural design and project coordination of heavy industrial and commercial buildings. Past year managing own light construction business. Salary, $9,600. C-636.

CIVIL ENGINEER, A.M. ASCE, B.S. Three years U.S. Navy Civil Engineer Corps, airfield construction and maintenance, college civil engineering instructor. Salary, $7,000. C-637.

CIVIL ENGINEER, M. ASCE, B.S.C.E., P.E. Six years foreign construction as soils engineers with arch.-engineers, corps of engineers and prime contractor; three years in consulting office on design and plans of roads and highways, and some structural design. C-638.

CONSTRUCTION SUPERINTENDENT OR RESIDENT ENGINEER, F. ASCE. M.C.E., P.E.-N.Y. and Miss. Eighteen years on construction supervision, designing, planning and estimating; and an additional 12 years on building and heavy construction in U.S. and abroad. Salary, $12,000, minimum. C-639.

This is only a sampling of the jobs available through the ESPS. A weekly bulletin of engineering positions open is available at a subscription rate of $4.50 per quarter or $14 per annum, payable in advance.

PROFESSOR OF CIVIL ENGINEERING, F. ASCE, M.C.E., 38. Six years of recent teaching experience, including mechanics, structural and concrete design courses, and graduate courses in theory and design, and 12 years of diversified industrial experience in design and research. Desires position at a university. C-640.

CIVIL AND STRUCTURAL ENGINEER, M. ASCE, B.S.C.E. P.E. Nebraska, 39. Six years of experience designing hydraulic structures for dams, and 6 years planning and designing highway bridges, water and sewage treatment structures and building foundations. Salary, $8,500. Prefer Midwest. C-2021-Chicago.

STAFF ENGINEER, A.M. ASCE, B.S.C.E., Licensed Indiana, 33. For seven years with metal fabricator on sales and construction; one year field engineer with consultant and for 2 years field engineer with contractor. Prefer Midwest. C-2022-Chicago.

ASSISTANT MANAGEMENT ENGINEER, M. ASCE, CE, Masters in Public Health, 36. Eight years of varied experience in the design, construction and supervision of public works and 6 years of experience in management and supervisory positions. Seeks engineering administrative position in construction firm. Salary, $8,000. Prefers Midwest or Far West. C-2023-Chicago.

DIRECTOR OR MANAGER OF ENGINEERING, F. ASCE, BSCE, 57. For 25 years in the planning, designing and supervision of construction of bridges and industrial, commercial and institutional buildings and plants, including utilities, mechanical and electrical equipment and transportation and shipping facilities. Salary, $15,000. Prefer, South or Midwest. C-2024-Chicago.

CIVIL ENGINEER, A.M. ASCE, R.S.C.E., Registered Professional Engineer, 28. Has three years of experience in highway work including engineering reports and complete plan development. Military completed. Prefer Florida. C-2025-Chicago.

STRUCTURAL ENGINEER, M. ASCE, Graduate C.E., 47. For 18 years in structural design, design supervision and construction; both domestic and foreign. Especially acquainted with modern precast and prestressed concrete structures. Salary, $10,000. Prefer, Midwest, West or Foreign. C-2026-Chicago.

CIVIL ENGINEER, A.M. ASCE, BS, MSCE, 33. Several years of experience each in research, plant maintenance and new construction, and additional three years in maintenance and construction in Navy Civil Engineer Corps. Salary, $9,600. C-2027-Chicago.

STRUCTURAL ENGINEER, M. ASCE, B.S.C.E., 35. Twelve years on design of industrial and commercial structures, including specifications and field inspection. Special abilities in written and verbal communication. Salary, $9,600 a year. Prefer, Midwest. C-2028-Chicago.

STRUCTURAL DESIGNER, A.M. ASCE, B.S.C.E., M.S.-Structures, 32. Four years experience in highway overpasses and river crossings design and detail. Well experienced in efficient use of Bendix G-15 computer programs for geometrics, design and detailing of bridges. Salary, $7,800 a year. C-2029-Chicago.

CIVIL ENGINEER, A.M. ASCE, B.S.C.E., 28. Experience in urban highway design, foundations, concrete structures, industrial and municipal sewage and water treatment facilities, also experienced in design, construction and supervisory phases. Salary, $7,200. Southwest or Midwest. C-2002-Chicago.

ESTIMATOR OR PROJECT MANAGER, M. ASCE, B.S.C.E., 37. During a nine-year period with general contractors, duties ranged from field engineering to that of chief estimator with responsibility for bidding million dollar contracts. Salary, $10,000. Location desired, Chicago, West or Foreign. C-2042-Chicago.

PLANT ENGINEER, F. ASCE, B.S.C.E., 48. Eleven years' in reports and design of civil works. Fourteen years' in construction (heavy, industrial and chemical) as superintendent, resident, engineer, etc. Directed construction and planning; handled subcontracts, procurement and estimating. Salary, $10,400 a year. Location, Central or Southern States. C-2043-Chicago.

CONSTRUCTION SUPERINTENDENT OR PURCHASING AGENT, F. ASCE, Graduate C.E. Long experience in construction engineering, purchasing and field superintendent. Good experience with sub-contractors. Have intimate knowledge of costs and modern construction methods. Able to handle men. Salary, $9,600. C-2044-Chicago.

CHALLENGE WANTED, M. ASCE, B.C.E., Reg. Minn., 33. Six years of experience as estimator, purchasing agent, chief engineer and project superintendent for marine excavating contractor; another five years spent as estimator, purchasing agent, design engineer, plant manager and corporate treasurer for plastics custom molder. Wide knowledge of plastics, heavy construction and small business problems. Prefer Midwest. C-2045-Chicago.

HYDRAULIC ENGINEER

—Sedimentation Surveys—

required by

Water Resources Branch

Department of Northern Affairs and

National Resources

OTTAWA, CANADA

A professional Hydraulic Engineer is required to establish and conduct a systematic sedimentation survey program.

Salary—up to $9,800 per annum

Depending on Qualifications

Challenging Work

Numerous Fringe Benefits

Candidates must be university graduates and possess a number of years' experience in sedimentation surveys, hydrologic investigations or hydrometrics.

For details and application forms, write to

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OTTAWA, CANADA

Please ask for Information Circular 60-1258

ENGINEERS

STRUCTURAL DESIGNERS

Openings in our Cincinnati, Lansing and Louisville offices for graduate engineers for work on bridges and structural projects. Several years' experience desirable but not mandatory.

Overtime allowance, hospitalization, insurance and retirement program for continuing employees.

Submit experience record, references, locality preferred and salary requirements in first letter.

HAZELET & ERDAL

Consulting Engineers

405 Commerce Building

LOUISVILLE, KENTUCKY

Positions Available

CIVIL ENGINEER to work for prominent manufacturer of pressure piping. Must be experienced in design, construction, operation and maintenance of municipal water supply and must be capable of interpreting pipe requirements for the design of pipes for various field conditions and service. Work will be in association with research and production departments as well as national and local engineering and specification authorities. New York City. W-9914.

STAFF ENGINEER, civil or industrial engineering graduate, with 10 to 15 years of experience covering estimating, office engineering, methods and procedures, job analysis, training and administration in municipal engineering and industrial construction including some oil field or refinery work. Salary, $10,000-$15,000 a year. Middle East. F-9908.

ENGINEERS. (*a*) Sanitary engineer, B.S. or M.S. in civil engineering, major in sanitary engineering preferred. (*b*) Architectural engineer, degree in architecture with experience in design of sewage treatment and water treatment plants. Apply by letter including detailed statement of personal record, age, education, experience, availability, salary expected. Northern N.J. W-9905.

ENGINEER, graduate of recognized engineering school in electrical, mechanical, structural or civil engineering, with at least five to ten years of experience in building construction and alteration. Must have design experience of heating, ventilating and air conditioning systems, boilers and air conditioning equipment, pumps and piping practice, plumbing systems, exhaust systems and a working knowledge of electrical systems for multi-story buildings, lighting, sound systems. Salary, $10,000 a year. New York City. W-9902.

CHIEF ENGINEER, to assume overall responsibility for all engineering, construction and maintenance activities and services for an oil company; graduate mechanical engineer preferred. Salary, $12,072-$13,986 a year, plus a subsistence allowance; tax free. Family housing available; good vacation, medical and life insurance programs. Middle East. F-9901.

DEPARTMENT HEAD, civil engineering, Ph.D., preferably with some teaching experience. Midwest. W-9888.

TRAFFIC ENGINEER, experienced in traffic analysis for major highway systems and municipalities. Knowledge of highway design desirable. Pennsylvania. W-9887.

HIGHWAY CONSTRUCTION ENGINEER, with 10 to 15 years of experience, preferably in a state highway department. $14,000, plus allowance of $3,300 if married and $2,100 if single. Eighteen month contract. Far East. F-9885.

DESIGN ENGINEER, Civil-Structural, graduate, with 5 to 7 years of experience on structural design of hydroelectric dam, power station, flood spillways, etc., for 2 years; family status. Salary high plus allowance. Far East. F-9847(b).

ENGINEERS. (*a*) Budget and fiscal specialist, to assist government in organizing a department of highways in the ministry of public works for the planning, administration, coordination and supervision of all highway activities and appurtenant services. U.S. citizenship required. Broad knowledge of highway and fiscal budgeting and control. $12,000 plus housing. Two year contract. (*b*) Highway construction engineer, to supervise construction of highways and bridges. Minimum of 10 years of experience on construction supervision of highways. Single status only. U.S. citizenship. Two year contract. To $12,000, plus housing and subsistence. South Vietnam. F-9845.

STRUCTURAL DESIGNERS, Grad. CE for design of industrial, institutional and laboratory buildings. Minimum 5 years of experience in structural design in either structural steel or reinforced concrete. Specialized experience in foundation design or prestressed concrete design will be considered. Salary to $9,000 depending on experience. Detroit. C-8359.

ENGINEERS. (*a*) SENIOR REGIONAL ENGINEER, Grad. CE or Structural. To be responsible for Chicago Office operations including Northern Illinois and Indiana doing promotional field work in uses of structural steel. Should be able to discuss design problems encountered in structural steel. Must be interested in promotional work and present subject well, Salary open. (*b*) REGIONAL ENGINEERS. Requirements as above. Territories: Columbus, Ohio, including Southern Indiana and Northern Kentucky; Nebraska Headquarters-Omaha, including Western Iowa, Nebraska and Wyoming, Colorado and Western Kansas; Minneapolis headquarters including Minnesota, North and South Dakota, Eastern Montana and Western Wisconsin. Should be registered structural engineer or able to obtain license for a trade association. Employer will negotiate the fee. C-8282.

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As a further service to our readers we will periodically make available this new system which greatly simplifies the procedure for obtaining additional data on advertised products, new developments reported by manufacturers in "Equipment, Materials and Methods and Literature Available." Instead of writing separately to each manufacturer, you need only circle the items you would like to receive on the coupon printed below and mail it to:

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CIVIL ENGINEERING
33 West 39th Street ▪ New York 18, New York

For information on products advertised in this issue, circle the appropriate page number on the left-hand coupon; for items listed in "Equipment, Materials and Methods and Literature Available," circle the appropriate key number listed on the right-hand coupon. In addition to your name and address, be sure to include your title and firm name on the coupon. All information will be sent directly to you from the manufacturers. *Not good after March 15, 1961.*

January, 1961—Products Advertised

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PLEASE SEND me more complete engineering information on the products advertised in the pages circled below.

IFC	19	86	109	121
2	20	87	111	122
4, 5	21TR	88	114	123
7	21BR	89	115	124
8	22, 23	90	116TL	125
9	24, 25	91	116BL	126
10, 11	26	92	117	127L
12	27	93	118	127R
13	28	94	119TL	128BL
14, 15	30	96	119BL	128TR
16, 17	32	105	119R	129
18	85	108	120	IBC

Note: The following code identifies the location of the ad when more than one avertisement appears on a page: T-top, B-bottom, L-left, R-right, IFC-inside front cover, IBC-inside back cover.

Name .....
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January, 1961—Equipment, Materials, Etc.

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PLEASE SEND me more complete engineering information on the items featured below.

CE-1	CE-12	CE-23	CE-34	CE-45	CE-56
CE-2	CE-13	CE-24	CE-35	CE-46	CE-57
CE-3	CE-14	CE-25	CE-36	CE-47	CE-58
CE-4	CE-15	CE-26	CE-37	CE-48	CE-59
CE-5	CE-16	CE-27	CE-38	CE-49	CE-60
CE-6	CE-17	CE-28	CE-39	CE-50	CE-61
CE-7	CE-18	CE-29	CE-40	CE-51	CE-62
CE-8	CE-19	CE-30	CE-41	CE-52	
CE-9	CE-20	CE-31	CE-42	CE-53	
CE-10	CE-21	CE-32	CE-43	CE-54	
CE-11	CE-22	CE-33	CE-44	CE-55	

Note: Code number identifies location of item in Equipment, Materials and Methods, Literature Available and Films Available, starting on page 113.

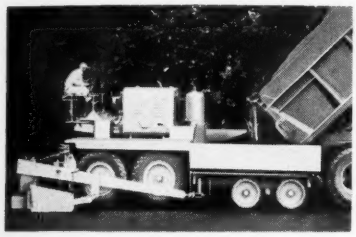
Name .....
Title .....
Company .....
Address .....
City, Zone and State .....

EQUIPMENT, MATERIALS and METHODS

NEW DEVELOPMENTS OF INTEREST AS REPORTED BY MANUFACTURERS

Bituminous Finisher

The manufacturing and sales rights for a complete new line of asphalt finishers, developed by the Advanced Construction Equipment Corp. have been acquired by The T. L. Smith Co., 2835 North 32nd Street, Milwaukee, Wisconsin. First in the line, the Mark IV, with over 400 ton per hour capacity, incorporates many significant engineering improvements not previously available on asphalt paving machines. Following a steady trend in the construction industry, it is mounted on rubber tires for smoother, faster operation. The manufacturer reports paving speeds up to 102 ft per min and traveling speeds up to 10 mph are now possible. This, combined with unique front and rear wheel steering, provides exceptional maneuverability and ease of handling. Paving around sharp curves, next to curbing and over old broken pavement is said to be faster and more uniform.



The Mark IV

Additional features include: swept back screed for faster, more even distribution of the mix; a swinging operator's platform for unobstructed visibility to right and left; extra flotation with large pneumatic tires; and folding side wings on the hopper to permit trucks of all sizes to unload mix without spillage yet move the entire load to the conveyor without hand shoveling or prodding. **—CE-1**

Rubber Expansion Joints

THE EXPANSION AND SHRINKAGE of pipelines caused by extreme fluctuations in temperature are a constant source of concern in line maintenance, efficiency and safety. Multi-purpose expansion joints produced by a Dutch firm, Vredestein International, provide for just such variations by absorbing both expansion and shrinkage. They are available from The Netherlands Trade Commission, 551 Fifth Avenue, New York, N.Y., in low and high pressure units that can be employed in existing pipelines as well as in new ones, allowing for soil settlement, insulation of electric current and deadening of sound. For pressure lines, the expansion joints are available in diameters of up to 80 in. For working pressures of up to 25 atm, at which the bursting strength is over 80 atm, the maximum diameter is 4 in.

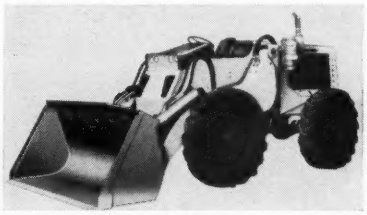
In addition to bridging assembly tolerances, these rubber joints resist sea water, oil, acids, caustic alkali solutions, atmospheric influences and tropical conditions. Light-weight, with short insertion lengths, the joints, in the case of suction and pressure lines of sand suction dredgers, resist wear. Equipped with a rubber flange, the joints also serve as gaskets or seals between pipe sections. **—CE-2**

Reproduction Machine

A 12-IN. CAPACITY PHOTOCOPIER has been announced by F. G. Ludwig, Inc., Old Saybrook, Conn. Lightweight, compact and portable, the Contouramatic Mark III makes the photo-exact, permanent black and white copies of any mark on paper, including ball point pen, colored inks or crayons, spirit duplication and rubber stamped copy. Up to 12-in. wide originals of any length can be copied on regular bondtype, featherweight, card stocks as well as various films for reproduction masters. All controls, copying operations, and paper storage are up front for easy access. The machine may be placed against a wall or in a corner, saving desk space. **—CE-3**

Front End Loader

IN THE INTRODUCTION of a 3-yd, 9000-lb capacity front end loader, The Thew Shovel Co., Lorain, Ohio, claims to have designed a machine that is superior in dump height, forward reach and cycle time to any now on the market in this class. Designated as a Lorain ML-309, it broadens the loader line to include machines from 1¾ to 3 yd and 6000 to 9000

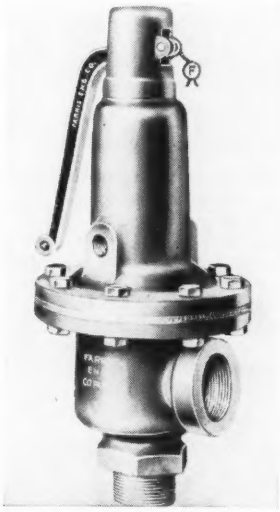


ML-309

lb carry capacities. It has a lifting capacity of 18,000 lb. Other features include: balanced design, the power and weight for good digging penetration, adequate hydraulic power for fast bucket roll back and a new "fast fill" bucket design that when in carry position holds the crown of the load to the back of the bucket which prevents dribbling. **—CE-4**

Vapor Tight Seal

A SUPER SENSITIVE Diaphragm Relief Valve for service where corrosive chemicals are a problem is now available from Farris Engineering Corp., Palisades Park, N.J. The 1000 Series Valve provides a vapor tight seal to prevent leakage and eliminate waste. Its spring and guides



Relief Valve

are isolated from the process fluid to avoid corrosion problems. Available in a wide choice of materials, the valve may be mounted in horizontal or vertical position. It is excellent for chemicals, slurries, and for nitrogen and other light gas service where an absolutely tight relief valve is required. **—CE-5**

"On-The-Run" Tire Inflation

AN IMPORTANT NEW PERFORMANCE feature for subgrade, base and asphalt compaction with the SP-730B Self-Propelled Pneumatic Tire Roller is now available from Bros Inc., Road Machinery Div., 1057 Tenth Ave., S.E., Minneapolis 14, Minn. An "on-the-run" tire inflation device for new rollers as well as a modification kit for all SP-730 rollers now in the field is offered that allows the roller operator to increase and decrease tire pressures quickly during rolling operations.

This revolutionary new and convenient feature eliminates stops for changing ballast for "stage" compaction of weak or wet subgrade materials; with the "stage" method, the roller will build bearing strength with low tire pressures and densities with increased tire pressures without ballast changing. **—CE-6**

(continued)

Soil Tester

A SMALL DEVICE to give accurate field tests for moisture density in a wide range of embankment and foundation soils, is announced by Charles R. Watts Co., 4121 Sixth Ave. N.W., Seattle 7, Wash. Designed for holes up to 0.15 cu ft in volume and 8 in. deep, the Model 15 Washington Dens-O-Meter is convenient for one man operation in fine or coarse granular base soils and gravels, calculated to cover 90% of test needs at lower cost. Parts are interchangeable with the standard Model 30. Both models were developed by soil engineers. —CE-7

Sectional Shoring

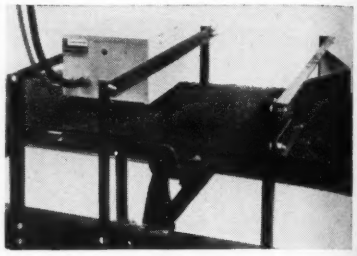
A MINIMUM NUMBER of sectional steel shoring frames, manufactured by The Patent Scaffolding Co., Inc., 38-21 12th St., Long Island City 1, N.Y., are being used in the construction of two 300-ft dia water tanks at Provin Mt. Reservoir, Feeding Hills, Mass. By rolling, lifting and again rolling the shoring from pour to pour in both tanks, the contractors are saving considerable time and equipment costs. As pour areas are completed, shoring sections with formwork in place are lowered on adjustable screw legs. Hydraulic shoring dollies are moved beneath these sections which are then rolled to new pour areas in each tank. The easy-to-handle "prefab" end frames are rapidly assembled to form basic, free-standing units with practically any frame spacing required. —CE-8

Highway Sign Assembly

USE OF HIGH-STRENGTH bolt fasteners, produced by Huck Mfg. Co., 2480 Bellevue Ave., Detroit 7, Mich., to assemble highway signs has substantially reduced installation time and maintenance costs for a state highway department in the south. Trucks equipped with air compressors and tanks permit assembly and erection of signs right on the job. The supporting frames are assembled on location, permitting greater payloads per trip. A two-piece design consisting of a pin and a collar, the Huckbolt fastener combines the desirable features of both a bolt and a rivet. —CE-9

Moisture and Density Control

FOUR INSTRUMENTATION SYSTEMS for the continuous measurement and control of moisture and density of materials have been developed by the Industrial Division of Nuclear-Chicago Corp., 359 East Howard Ave. at Nuclear Dr., Des Plaines, Ill. The "Qualicon" Systems include: Model 502 for measurement and control of the bulk density of solid materials either on a conveyor belt or in a bin or hopper, Model 507 for the percent moisture of solid materials on a belt or in a storage facility, Model 504 for the specific gravity of solutions and slurries in pipes or tanks, and Model 509 for the percent moisture of liquids or slurries in a process loop or in a tank.



Model 502

Each system consists of three basic parts: a measuring head, an electronic read-out and a recorder/controller which displays the desired information and controls the measured variable. Each can be provided with either analog or digital data presentation and control. Density measurements make use of gamma reflection and transmission, and moisture measurements are accomplished by the principle of neutron reflection. —CE-10

Greater Beam Strength

A GROUSER SHOE, which in laboratory tests demonstrated nearly 25% greater beam strength than other leading brands, has been announced by WesTrac Co., Dept. G., 1309 W. Sepulveda Blvd., Torrance, Calif., manufacturers of replacement parts for crawler tractors. The increased beam strength, assisted through added steel to the rear of the grouser (sand trap), and added steel in the lower base section of the grouser lug, enables this new shoe to withstand more severe impacts without breaking or bending. Impact resistance is further multiplied by a specially-developed heat-treat process culminating in high frequency electrical induction tempering. The shoe is completely interchangeable with the original equipment and may be used in complete groups or intermixed with any interchangeable grouser shoes. —CE-11

NEW! MODEL 15
SMALL COMPANION
to the Standard Model

SAME Accuracy . . .
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LOWER PRICE!

WASHINGTON Dens-O-meter

THE KEY TO ACCURATE FIELD TESTS FOR MOISTURE-DENSITY IN EMBANKMENT AND FOUNDATION SOILS.

The DENS-O-METER is light in weight, compact, very portable, easy and economical to operate and maintain!

Developed after years of research by Department of Highways, State of Washington. Opens up entirely new possibilities for foundation and soils engineers and contractors who can now make accurate moisture-density and compaction tests, quickly and easily.

- in small or large holes up to 0.15 cu. ft.—8 in. deep
- in all types soils and granular base materials
- in approximately 3 minutes after hole is dug

CONTRACTORS AND ENGINEERS: Stop over-compaction, under-compaction . . . make moisture-density determinations many times daily with a DENS-O-METER.

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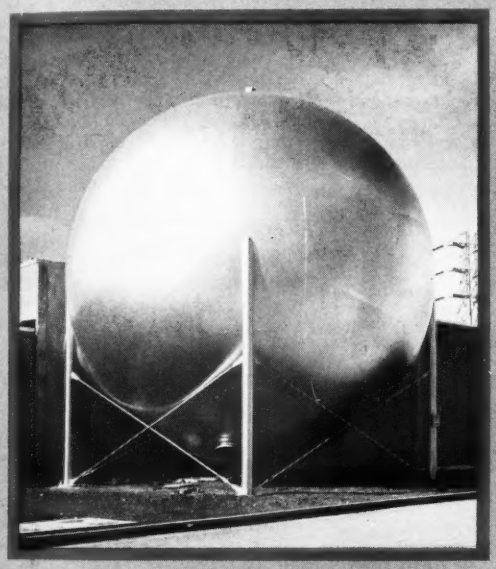
HORTONSPHERE helps advance missile technology

The flight of a ballistic missile entering the earth's atmosphere is simulated in an Atmosphere Entry Simulator built by the National Aeronautics and Space Administration at Ames Research Center, Moffett Field, California.

Employing the Ames Simulator, space scientists quickly and economically determine in the laboratory whether a specific design can survive re-entry.

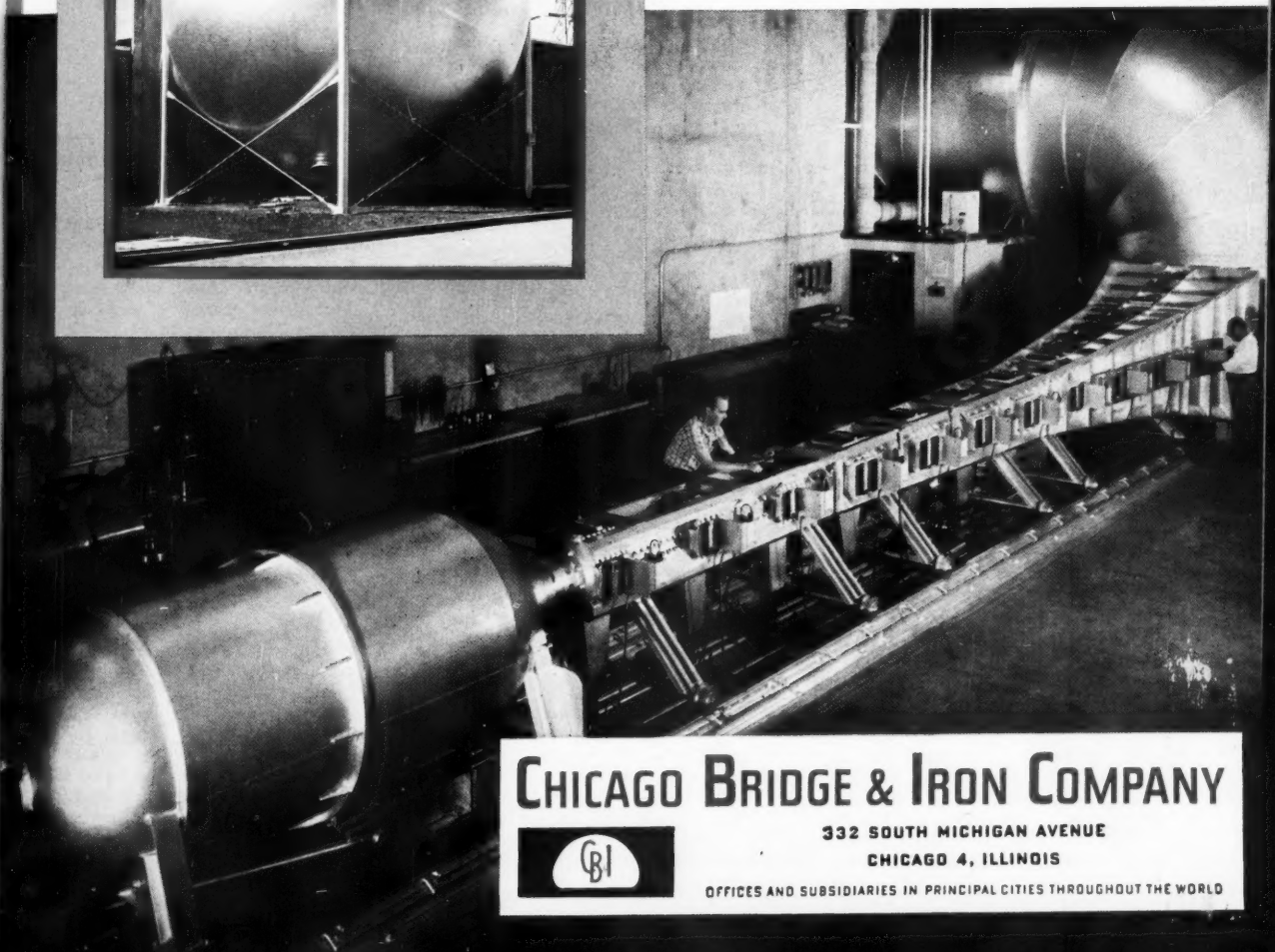
CB&I fabricated and erected several vital components for this important research facility. Included are a 30½ ft. diameter steel vacuum sphere and a 10 ft. diameter duct and elbow.

Craftsmanship in Steel—skillfully developed by CB&I over more than seven decades—builds quality into plate structures for any kind of service.



CB&I fabricated and erected steel vacuum sphere (left) and 10 ft. diameter duct and elbow (below, far right) for the Ames Atmosphere Entry Simulator.

E66CB



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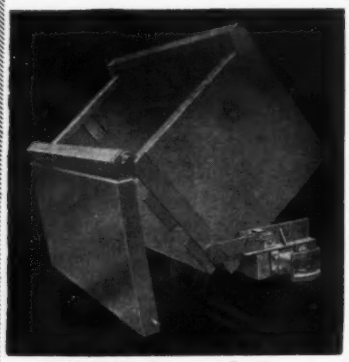

MAYO Tunnel Cars

. . . feature practical designs and rugged construction. All cars can be equipped with Mayo's safe, automatic couplers.

- Side Dump Car (shown) has 2½ cu. yd. capacity. 24" gage.
- Rooker Dump Car. Ideal for sticky muck or wet concrete. 1 cu. yd. capacity 24" gage.
- Tunnel Car. Box body is removable and may be hoisted to surface to be dumped into truck. ½ to 2 cu. yd. capacity. 18" or 24" gage.

FREE Bulletin No. 18-b shows car details; No. 22 illustrates Automatic Coupler.

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EQUIPMENT, MATERIALS and METHODS

(continued)

Optical Reading Machine

BOTH TYPED AND PRINTED business information can now be read directly into a computer memory for high-speed data processing. This announcement was made by International Business Machines Corp., Data Processing Div., 112 East Post Road, White Plains, N.Y., with the introduction of its 1418 optical character reader. The unit reads data printed in widely-used type styles on paper or cards, at a rate of 480 characters per second, or as many as 400 documents per minute. The printed data is automatically translated into machine language for direct input to an IBM 1401 computer. The reader handles documents of various sizes and thicknesses. Forms can be anywhere from 5⅞ in. to 8¾ in. wide by 2¾ in. to 3⅓ in. high. Their thickness can vary from that of bond paper to IBM card stock. Any printed documents within these dimensions, premium notices, imprinted charge slips, telephone bills, tax notices, coupons, and continuous-card forms, can be used as direct input to the 1418-equipped 1401 system. **—CE-12**

Cement

GARONITE, A HEAVY DENSE gray cement which dries without shrinkage to a mass of great strength, has been developed as an anchoring medium for any type of machinery or concrete installation, including heavy-duty vibrating equipment. Developed by Garon Products Inc., Longfellow & Viele Avenues, Bronx 59, N.Y. it may also be used for patching concrete floors, and other repairs of emergency nature demanding early use.

The cement is applied cold by adding water. It sets so quickly that machinery anchored with it may be used within thirty minutes to one hour, depending upon size and weight. At one hour compression strength of the cement is guaranteed to exceed 5000 psi, increasing to more than 12,000 psi full strength. Advantages to Garonite include savings in time, labor, cost of material and replacement of anchors due to excessive vibration and strain of heavy equipment. An absolute shrink-proof union between bolt and base assures permanent anchorage for any type of installation. **—CE-13**

Paving Material

A NEW LONG WEARING, skid resistant, "non spattering" road surfacing material will be manufactured by Barrett Div., Allied Chemical, 40 Rector St., New York 6, N.Y. Skid tests have shown that an automobile can be brought to a safe stop on a wet surface of the asphalt-based material at least one car length sooner, at normal road speeds, than on conventional surfaces when wet. Another advantage is that it eliminates the noise, mess and delays associated with conventional treatments involving a coating of tar or asphalt overlaid with sand or crushed stone. **—CE-14**

Compression Machine

A COMPLETELY POWER OPERATED portable compression machine with a widely variable speed of loading is the Model FT-30, manufactured by Forney's Inc., Tester Division, P.O. Box 310, New Castle, Pa. The conventional manually operated pump is eliminated because in addition to the variable speed feature, the new power control unit embodies a rapid traverse which permits fast preloading of the specimen. The speed at which a specimen is loaded can be preset according to the applicable ASTM or AASHO specification, and can be varied while the test is in progress. **—CE-15**

In filling out the request coupon, please print clearly and be sure that you furnish a complete address.

Transit Mixers

A COMPLETE LINE of extensively tested transit mixers has just been introduced by Blaw-Knox Co., Construction Equipment Div., Mattoon, Ill. Ranging in size from 4 to 10 cu yd, the "BuKaneer" transit mixers are available with fly wheel power take-off, front engine power take-off, and separate engine power trains. All three drives feature a heavy duty transmission which provides four forward and four reverse speeds. In addition mixer controls include air-electric operation for controlling drum direction. All controls are positioned fore and aft on the mixer. A tachometer, for indicating drum revolution rate, is standard on all models. Charging speeds range from 10 to 22 RPM, providing a rate of 5 to 8 sec per cu yd. Drum discharge speeds vary from 2 to 22 RPM. **—CE-16**

"BuKaneer"

Mars products are available at better engineering and drafting material suppliers everywhere.

Duralar:

WON'T SMEAR ON MYLAR - ERASES ON MYLAR

Specifically designed to work perfectly on matte-surface drafting film of Mylar®, Duralar is the newest in the complete line of Mars fine drafting products. All are imported from West Germany and are made to meet the highest professional standards. Shown: Mars-Lumograph Duralar pencil and lead—available in five special degrees, K1 to K5; Mars-Duralar Technico with adjustable Duralar degree indicator; Duralar eraser.

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This new pioneering Handbook covers all the means of testing the essential properties and performance capabilities of materials, parts, components, and structures *without impairing serviceability.*

Explains and illustrates applications, advantages, limitations of 24 different test methods applicable in every branch of engineering and industry. Specifications, equipment costs, hundreds of pages of test interpretation data. *Prepared under the auspices of the Society for Nondestructive Testing. 1,100 illustrations, graphs, tables; 1,910 pp. 106 Contributing, Consulting Editors. Robert C. McMaster, Ed. October, 1959.* 2 volumes, $24

PRODUCTION HANDBOOK

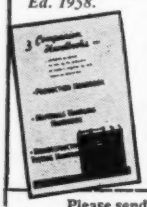
Packed with practical production know-how, this Handbook is the complete key to management-engineering methods that are revolutionizing industrial production today. Fully covers new materials, machines, processes, and proper functioning of company organization.

Supplies proved principles, time- and work-saving systems, and successful operating procedures for maximum productivity at minimum cost. Saves hours of research and costly experimentation. *726 illustrations, tables; 1,726 pp. 48 Contributing, Consulting Editors. Gordon B. Carson, Ed. 2nd Ed., 1958.* $16

MATERIALS HANDLING HANDBOOK

The complete guide to modern materials handling. This unique Handbook explains the governing principles, today's most efficient methods and systems, and recommended equipment for moving material at least cost — whether in raw, in-process, or finished form.

Useful in all industrial situations, Handbook answers every basic question of work flow within and outside the plant. *Sponsored by The American Society of Mechanical Engineers and the American Material Handling Society. 991 illustrations, tables; 1,740 pp. 84 Contributing, Consulting Editors. Harold A. Bolz, Ed.; George E. Hagemann, Assoc. Ed. 1958.* $20



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EQUIPMENT, MATERIALS and METHODS

(continued)

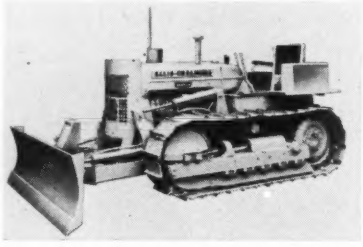
Economical Marker

A FLEXIBLE TRAFFIC MARKER is now available at reasonable price for traffic control on highways, plant sites, parking areas and construction jobs. Made with long-lasting "Hypalon" synthetic rubber, the brilliant yellow tubular marker snaps back even when hit by a car at 60 mph. It stands erect throughout its long service life, but avoids the damage to tires or fenders caused by pipes or other rigid markers. Manufactured by E. I. du Pont de Nemours & Co., 7529 Nemours Building, Wilmington 98, Del., "Hypalon" is the only elastomer which will retain coloration, toughness and resiliency under exposure to sun, weather, oils, grease and ozone-charged atmospheres characteristic of heavily traveled highways. The markers can be dismounted and moved, permitting ready revision of traffic control plans without unnecessary expense. —CE-17

To obtain more information about these products please turn to page 112

Crawler Tractor

BOTH THE H-3, powered by a 43 hp gasoline engine, and the HD-3, with a 40 hp diesel engine, are in the 3-ton weight classification and enable Allis-Chalmers Mfg. Co., Tractor Group, Milwaukee, Wisc. to offer a line of crawler tractors providing net engine hp ratings from 40 to 225 hp. The H-3 is powered by the Power-Crater 4-cylinder 149 cu in. piston displacement gasoline engine which has a 3½ x 3⅞ bore and stroke, 7.5:1 compression ratio, and is rated at 1650 rpm. The diesel engine of the HD-3 is also 4 cylinders, but has a 3 $^{9}/_{16}$ x 4⅜ bore and stroke, and a 15.35:1 compression ratio. It is also rated at 1650 rpm. Other features include a Shuttle clutch with 3 positions: forward, neutral and rearward, that eliminates foot clutching or gear shifting, and provides smooth, intermediate precision control between forward and rearward. —CE-18



HD-3

Rubber Waterstop

APPROXIMATELY SIX MINUTES are required to splice Aquastop, the new rubber waterstop introduced by Presstite Div., American-Marietta Co., 39th and Chouteau, St. Louis 10, Mo. The splice is chemically bonded instead of being heat-sealed or vulcanized. All that is required is a small splicing kit and a simple clamping device. Government requirements are met or exceeded by both the waterstop and the splice. Applications include areas where seepage and leakage must be prevented in concrete joints: dams, reservoirs, power stations, canals, pumping and water stations, tanks, bridge abutments, and foundations. —CE-19

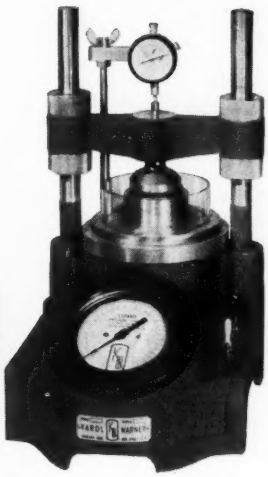
Epoxy Concrete

POT HOLES, BROKEN, shattered and spalled P.C. concrete pavements can now be repaired or replaced and put back into service in less than 24 hr with Topkote LP/Epoxy Concrete. According to the formulators and suppliers, Topkote Products Co., 645 Custer St., Evanston, Ill., this new replacement material develops compressive, tensile and flexural strength sufficient to carry normal automobile and truck traffic in 6 to 8 hr at 75 deg F. The concrete is formulated from Epoxy Resin and Polysulfide Liquid Polymer. It is mixed at the job site with local sand and gravel acceptable to highway specifications. No water or Portland cement is used with the mix. No curing is needed. The material will not shrink at joints. It is impervious to temperature extremes and is unaffected by salt brine. Slab replacements as deep as 8 in. have been successfully laid in areas of 5 ft by 20 in. With properly graded sand it can be feather edged. —CE-20

Ripper Point

DESIGNED TO DRAMATICALLY INCREASE ripping yardage, a new ripper point has been introduced by the Construction Equipment Div., Electric Steel Foundry Co., 2141 N.W. 25th Ave., Portland 10, Ore. The increased production is made possible by the radical length, narrowness and sharpness of design, and a new ESCO alloy developed especially for ripping. In extensive field testing the point has ripped material previously unrippable and has performed from two to ten times longer than other points. The extra length of the point shatters material well ahead of the ripper shank, greatly reducing shank wear. This feature, coupled with the flat pitch of the point design, reduces the drawbar load and allows the tractor to operate in a higher gear. Reduced drag permits the addition of extra ripper shanks. —CE-21

Unmatched for Efficient Consolidation Soil Testing...



OLSEN Conbel

- Infinite choice of loads
- Load applied instantly without shock
- Capacities from 750 lbs. to 10,000 lbs.
- Simplified controls—one man operation
- Air operated—no dead weights
- Compact . . . light weight . . . portable

For information about the Conbel and other modern K-W soil testing equipment for triaxial, unconfined compression, and direct shear testing . . .

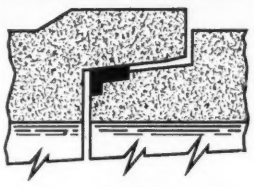
Write for Bulletin 50-A

TINIUS OLSEN TESTING MACHINE CO.

2170 Easton Road Willow Grove, Pa.

Fast, water-tight coupling for OFFSET CONCRETE PIPE *with*

TYLOX "C-P" GASKETS



Type "C-P" TYLOX under full compression on offset concrete pipe.

TYLOX "C-P" Gasket is designed for concrete sewer pipe having either single or double tongue offsets. Gasket consists of heavy base, multiple sealing fins, and a positioning flange which overhangs the edge of the tongue offset. "Locking" effect of the flange holds gasket in true position as pipe is coupled.

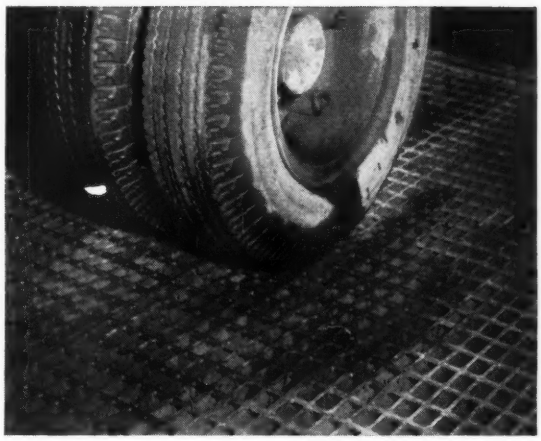
"C-P" Gaskets are the true compression type available in either rubber or neoprene, and withstand head pressures up to 50-feet. They may be installed at the job site, or the pipe manufacturer's plant Specially compounded to resist sewerage and industrial waste acids, they never deteriorate Write for brochure

5139

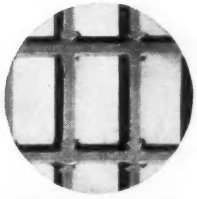
HAMILTON KENT MANUFACTURING CO.

KENT, OHIO ORchard 3-9555

CANADIAN: 10 Brussels St., New Toronto, Ontario



Heavy mobile loadings call for Gary HEAVY-WELD STEEL GRATING



Advanced design of Gary Heavy-Weld Gratings makes them ideal for any installation where heavy-duty open steel flooring is desirable. New design has the capacity to sustain heavy mobile loadings imposed by highway vehicles, lift trucks, and all classes of aircraft. Straight clean lines of the rectangular pattern permit unimpeded flowage and afford maximum open area. Wide range of sizes and meshes makes Gary Heavy-Weld Gratings adaptable for a variety of applications.

- **Airfield drainage covers**
- **Industrial floor openings**
- **Aggregate screens**
- **Highway inlets & trenches**
- **Vehicular ramps**
- **Trash racks**
- **Scrubber trays**

A New Catalog has a unique series of charts for use in determining the exact size and type of Heavy-Weld Grating for your particular application. Handy tables simplify the problem of specifying exactly the right grating for every load requirement. For your free copy of catalog No. H-760 write today to Dept. A-8

ROCKWELL-STANDARD CORPORATION

Grating Division, Gary, Indiana

(continued)

Signaling Device

THE WARNING-SCOPE, manufactured by Hawkins-Hawkins Co., Inc., 1255 Eastshore Highway, Berkeley, Calif., is uniquely designed to be compact when collapsed, 6 in. by 42½ in., and when extended reaches 9 ft 1 in. When 24-in. flags are added, a height of 11 ft is reached. Leg spread covers a diameter of 61 in., and flags spread horizontally to 61 in. Telescoping tubes of the signaling device lock, with knurled sleeves turned easily by finger tightness, to any height desired. Tubes and knurled sleeves are all high tensile aluminum. Exceptional features include ease of repair and maintenance. All components are available for replacement. No rivets are used, only locking bolts and nuts. —CE-22

Floor and Roof Slabs

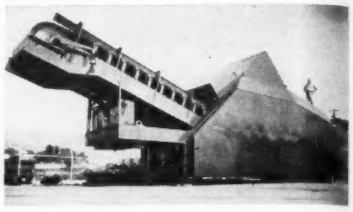
FAB-FORM 25, a heavy-duty corrugated permanent steel form for floor and roof slabs, has been developed by Pittsburgh Steel Products Division, Pittsburgh Steel Co., Grant Building, Pittsburgh 30, Pa. The form is fabricated from cold rolled full hard sheet steel in almost any length desired. It is available plain or Bonderized with a Du Pont primer that is baked on at temperatures up to 650 deg F. A 20-day salt spray test at the Du Pont testing laboratory proved that the coated form has superior corrosion resistance to other sheet form products. It has a cover width of 30¼ in. and an over-all width of 32¼ in. Its corrugation pattern is 2¾ in. by 1 in. depth. —CE-23

Diamond Bits

A COMPLETE LINE of quality diamond bits is now being manufactured by Acker Drill Co., Inc., Scranton 2, Pa. Facilities completed several months ago are in full production of coring bits, thin wall bits, non-coring bits, reaming shells and other bits suitable for any drilling requirement. Field test results indicate that the rugged construction and modern design of these bits provide the ability to stand up under the most severe conditions. Each is hand set by experienced setters using selected, quality diamonds. —CE-24

High Tonnage Loader

A HIGH TONNAGE mobile belt loader, capable of pouring 3,500 tons of material per hour into hauling units, is the latest addition to the Western Conveyor Co., P.O. Box 357, Boise, Idaho line of construction equipment. Features of the new model loader are a continuous running belt and internal hydraulically-operated gate control and feeder. The positive



Continuous Running Belt

hydraulic cut-off of the discharge gate and feeder prevents dribbling or spilling of materials between loading discharges, and the continuous running belt eliminates shear and starting load. The fifth wheel pin is under the discharge end, permitting hook-up and movement by truck without crane lift or tractor pullout. The unit is equipped with tandem dual wheels to carry its 64,000-lb bulk, and is hauled intact by standard hauling equipment as a permit load. —CE-25

Dependable communications proved through extensive survey party testing under actual on-the-job conditions. Fully-transistorized, and with rugged aluminum case, this compact transceiver features exclusive "squelch" and offers FIVE battery options with extremely low battery drain. Survey parties have **proved** that in the field, Han-D Phone can **take** it... and keep right on talking back!

Kaar 25TH ANNIVERSARY

Please send complete information on the Kaar Han-D-Phone for field engineering application.

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KAAR ENGINEERING CORP.

2954 Middlefield Road, Palo Alto, California

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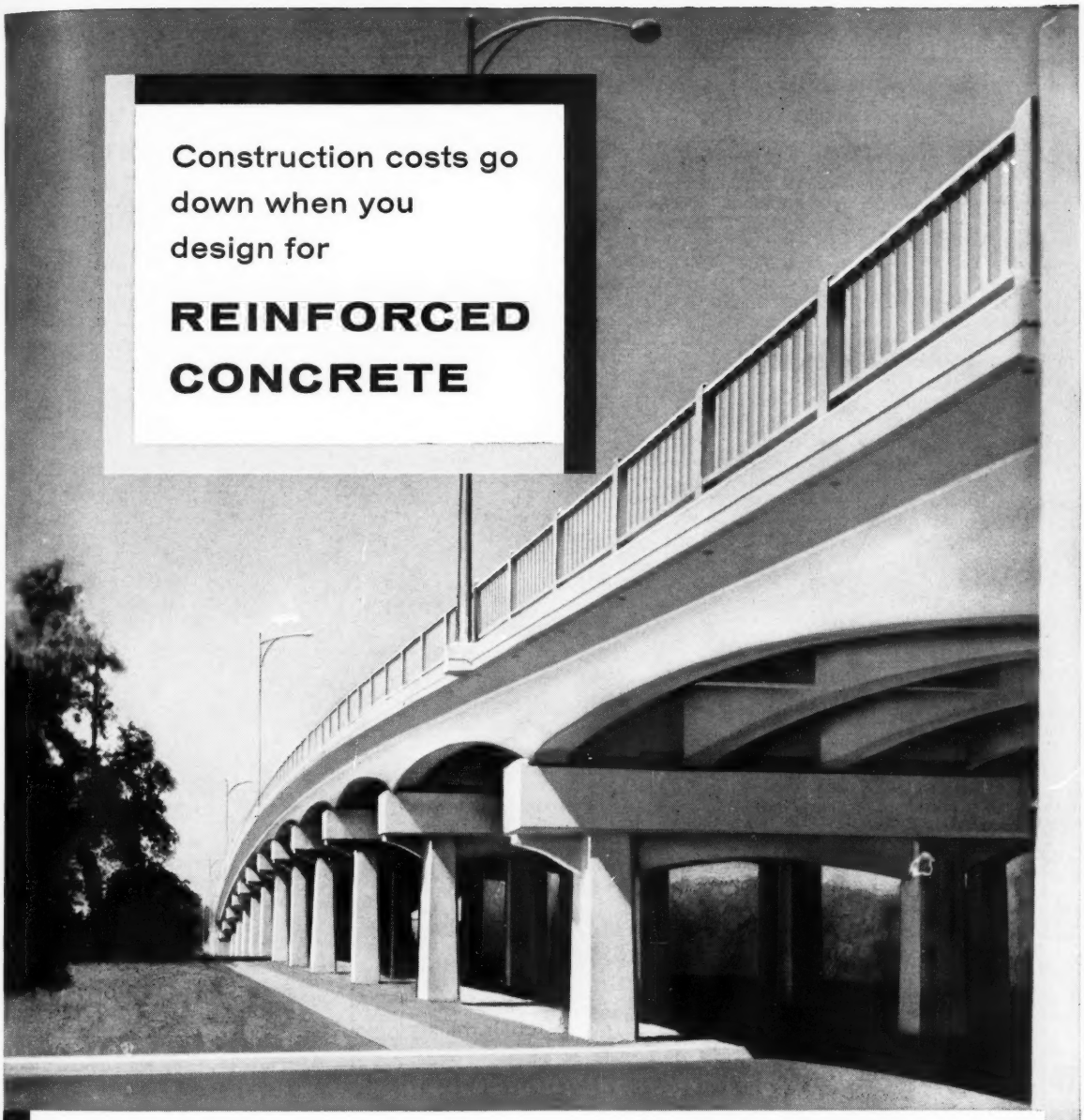
Concrete Forms

THE RE-USABLE, plywood-faced concrete pouring forms made by Symons Clamp & Mfg. Co., 4249 W. Diversey Ave., Chicago 39, Ill., were used, recently, to solve some difficult space problems in the construction of a building to house a central steam boiler plant, an incinerator and big compressors in the middle of an operating automobile assembly plant site. The limited space put a premium on tight scheduling, careful timing of deliveries, and the use of compact equipment. The key to space economy was the concrete formwork. By using the Symons forms, the contractor was able to form the walls, the ash trench, the triangular pile capping, and the bases for the compressors in a minimum of space. Pouring operations were held at a rate of 4 ft per hour by removing one panel from the built-up form at a 6-ft height, and using a laydown bucket to pour the first lift of concrete through the opening. Then the panel was replaced with its simple connecting devices, and the pour completed. —CE-26



10th Street Overpass on U.S. Highway 30, Caldwell, Idaho
Designers: State of Idaho, Department of Highways
Contractors and Engineers: Babbitt Construction Company, Boise, Idaho

When compared with other construction materials, the cost of reinforced concrete construction is usually less. Projects start on time, finish on schedule . . . no expensive delays due to material shortages or field design changes. In addition, you enjoy the added advantage of complete design flexibility to meet the requirements of varying elevations and terrain.

Reinforced concrete structures are lower in after costs, too! They require less maintenance—never need painting, and are resistant to wind, shock, and earthquake.

On your next project, design for reinforced concrete and compare its many superior advantages.

17-6

Concrete Reinforcing Steel Institute | 38 South Dearborn Street, Chicago 3, Illinois

(continued)

Elastomeric System

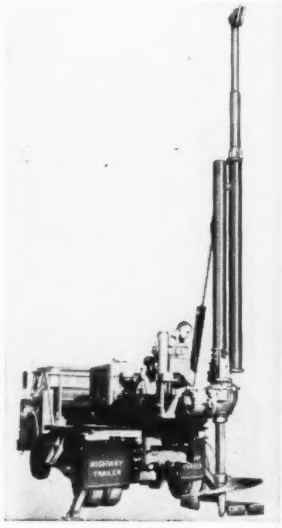
A FLUID-APPLIED roofing material contributing to freedom from design restrictions has been introduced by the Building Products Div., Armstrong Cork Co., Lancaster, Pa. The product, Armstrong F/A Roofing, was especially developed for weather proofing commercial and institutional building roofs of unusual configuration and can be specified for any type of climate. An elastomeric system, its use is significant in the construction and maintenance of thin-shell concrete or plywood surfaces which form hyperbolic paraboloids, domes, or folded-plate roofs. Application of the material may be accomplished through any of three methods: by air-operated, pressure-fed rollers, by hand rollers, and by conventional spraying equipment. —CE-27

Adaptable Device

UNINTERRUPTED FLOW of material is essential to profitable operation in the processing industries. Transit-O-Trol, an adaptable device manufactured by Industrial Physics & Electronics Co., 470 South 10th East, Salt Lake City 2, Utah, detects and corrects any departure from smooth and normal flow. It is a sensitive transistorized probe switch that can be applied to any material handling process in which a resistance probe can be used for sensing the position of a product. In mine-mill operations, the device can be employed on the feed box of ball or rod mills to prevent them from becoming choked with extraneous wood and other materials that cause chutes to plug. It also prevents ore bins from channeling and thus stopping the flow of feed while still containing a substantial amount of ore. It detects material handling failure at belt conveyor junctions and senses faulty operations in chutes, screens, feeders, pumps, valves and many other systems. —CE-28

Earth-Boring Machine

A NEW MODEL HFMS heavy-duty earth-boring machine for industry-wide multiple application, designed to swing up to a 60-in. auger in all types of soil, has been announced by Highway Trailer Industries, Stoughton, Wisc. A self-contained hydraulic Kelly bar provides variable speeds in feed and retraction, all from one easy to operate control. A 42-ft



Fully Hydraulic

sheave height is attained by a 3-stage hydraulic telescoping derrick. Versatile hydraulic all-way leveling allows 45-deg lateral for anchor holes and 25 deg under vehicle. The hydraulic feed ram is encased in a 4½-in square Kelly bar, which is rotated by an enclosed gear collar. The only hydraulic seal is on the top actuating ram, completely protected from outside contamination. —CE-29

Filtration Plant

A NEW, ODORLESS, maintenance free, high capacity, Controlled Filtration Plant for waste purification is now available from Project Fabrication Corp., 112-20 14th Ave., College Point 56, N.Y. The plant is furnished in a wide range of capacities and sizes to handle small as well as large waste loadings. Custom fabricated to meet user requirements, and constructed of aluminum, it is shipped completely shop assembled and ready to operate. Through a simple system of automatic controls a high degree of treatment is obtained making it possible to pass waste once through the filter and obtain clear and odorless water. —CE-30

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IMMEDIATE RESULTS!

NEW PORTABLE PAVEMENT DRILL BY ACKER

SPEEDS HIGHWAY CORE TESTING

65 CORES A DAY WITH HIGH SPEED ACKER DIAMOND BIT

- Full 360° angle drilling
- Hydraulically operated leveling jacks
- Adjustable core barrel guide
- Integral pump and 100 gallon water tank

In routine operation, Acker's new highway test core drill using special Acker thin-wall diamond bits is producing 65 or more quality test cores per 8 hour shift.

Trailer mounted for portability, this new rig features a 100 gallon water tank and pump; a new built-in core barrel guide that saves time; hydraulic leveling jacks that simultaneously level the rig regardless of road contour; and dozens of valuable, exclusive features.

Write today for Bulletin 32CE

ACKER DRILL CO., Inc. P.O. BOX 830 SCRANTON 2, PA.

Over 40 years of experience manufacturing a complete line of diamond and shot core drills, accessories and equipment.

310,000
LANDINGS AND TAKE-OFFS IN 1959!

On twenty-year-old runways paved with

CHEVRON ASPHALT

Back in 1940, Warren Bros. Company, Contractors, built these runways to Federal Specifications. They built them to last—with Chevron Asphalt!

Washington National Airport, noted for unobstructed approaches, is a 667 acre area located at a wide bend of the Potomac River. It has served during what must be regarded as the most hectic and active two decades of the air age!

As traffic handled at the airport increased over the years, the original paving has been added to and widened. The present pavement is equal in area to 30 miles of four-lane highway!

In 1953, the runways were sealed with BITUMULS RS-2 and clean, specially graded aggregate. This is the story of service, the story of *asphalt* service on an airport carrying an exceptionally heavy traffic load.

For information or typical specifications on runway construction, or on any type of paving, with Chevron Asphalt or Bitumuls Emulsified Asphalt, call our nearest office.

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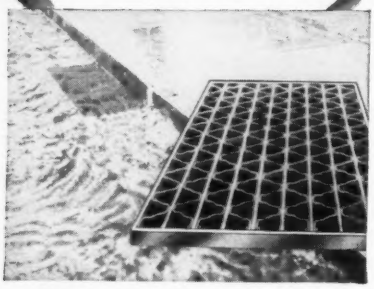
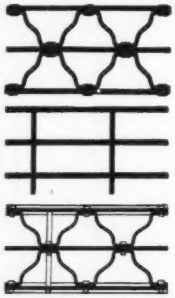
FLOODED HIGHWAYS HINDER TRAFFIC



OLD heavy cast iron draingrates, averaging at best 40% clear opening, often fail to carry off rain water fast enough during heavy downpours, resulting in flooded highways—particularly at underpasses. Also, cracked draingrates must be replaced.

With open steel mesh draingrates, larger clear openings reduce the likelihood of flooded highways considerably. Irving "Dryway" Draingrates are 75% open for greater drainage and are made of steel bars on edge, not subject to cracking.

Available in three basic designs:



Write for brochure on "Dryway" Draingrates
Self-maintaining, Lightweight, Economical, Safe

IRVICO

IRVING SUBWAY GRATING CO., Inc.
Originators of the Grating Industry

Offices and Plants at

5008 27th St., LONG ISLAND CITY 1, N. Y.
1808 10th St., OAKLAND 23, CALIFORNIA

EQUIPMENT, MATERIALS and METHODS

(continued)

Trencher

A 9/16-YD HYDRAULIC TRENCHER has been introduced by Ware Machine Works, Ware, Mass., for exclusive use on the Oliver "800" Industrial Wheel Tractor. This combination of a high-performance trencher with a rugged, 6150-lb tractor is said to provide the power and reliability to do an outstanding job on the most rugged contracts. Designated Ware

Hydro Trencher

"800" Hydro Trencher, it has an uninterrupted arc swing of 180 deg, breakaway capacity of 10,400 lb, and a maximum digging reach of 21 ft 11 in. It is available with or without cab. The "800" features full-vision operator positioning, multi-speed control of boom and dipperstick, power-locked stabilizers, new camel-back design of boom, straight-in-line cylinder power, and hydro-matic control of all boom operations. **—CE-31**

Clip-On Thermometer

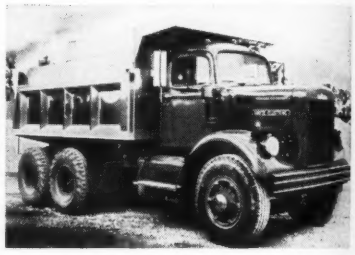
A NEW PIPE THERMOMETER that clips to steam, water, refrigeration, gas and other pipes, has been announced by the Abrax Instrument Corp., 179-15 Jamaica Ave., Jamaica 32, N.Y. The instruments can be attached or removed from the pipes in seconds by means of twin spiral spring clips, and require no alteration of the pipes. They are precalibrated to counteract the possibility of error through heat losses of radiation or convection. They can be used for all pipes up to 3½ in. dia, and come in two temperature ranges: No. APFT 460 for the range from +32 deg to 320 deg F and No. APFT 461 for the colder ranges of −14 deg to +134 deg F. **—CE-32**

Sludge Pump Control

A SLUDGE READER, manufactured by Komline-Sanderson Engineering Corp., Peapack, N.J., now eliminates the problems associated with maintaining proper sludge consistencies in sewage plant operation. Utilizing harmless nuclear energy, the Sludge Reader will react to changes in solids concentrations passing through the line and at a predetermined level, control the sludge pump. For instance, if it is desired to pump only sludge having a consistency of 4% or more from a clarifier, the Reader is set to stop the plunger pump when the consistency gets below 4% and restart the pump and keep it running when the sludge consistency reaches and maintains 4% or more. In pumping sludge from a clarifier to a digester or a dewatering device, the Reader can improve the sewage treatment plant's operating efficiency. In new installations it permits the use of smaller pumps, single pump operation from several tanks and a reduction of plant labor costs. **—CE-33**

Construction Truck

ENGINEERED EXCLUSIVELY for heavy duty operation, this construction truck Model 9064, with an 8 cu yd aluminum body and payload capacity of 30,000 lb, is manufactured by The White Motor Co., 842 East 79th St., Cleveland 1, Ohio. Powered by the White Mustang 462A engine developing 172 hp at 3200



Heavy Duty

RPM, this unit, with a wheelbase of 158 in. and a C.A. of 96 in., has a 507B selective type 5-speed forward main transmission with a 7231D 3-speed forward auxiliary transmission. It also has a SLHD tandem drive single reduction rear axle and a 116DX front axle. The frame is a double channel of chrome manganese steel, heat treated. **—CE-34**

Asphalt Plant

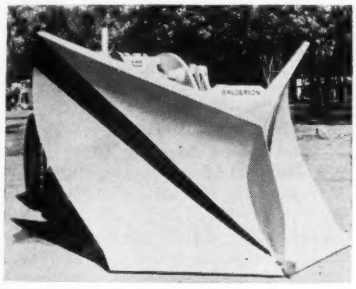
PORTABILITY IS NOW POSSIBLE with a continuous-mix, high-capacity asphalt mix plant manufactured by Barber-Greene Co., Aurora, Ill. Basically a Model 848-A B-G Plant, it may consist of any number of components: mixer, dryer, dust collector, etc., as dictated by job needs. The basic difference between the standard 848-A and this plant is in

(Continued on page 125)

the accessory and optional equipment. The portability is achieved by: rubber tire mounting of all components with dollies permanently attached to elevators, 85% of the dust collector duct work permanently mounted on top of the dryer, hinged exhaust stack on the dust collector, and storage provision for all loose parts on appropriate plant components. Set-up of the plant on the job site is speeded up by such design refinements as: hydraulically actuated support jacklegs, permanently mounted levels on all units, erection bolts minimized and standardized into two sizes, permanent mounting of electric wiring and panels onto each component with quick-connect fittings linking each, lineshaft drives color coded for quick connection, and built-in alignment devices on all components to facilitate correct positioning. **—CE-35**

Snow Plow

A BIG, FAST-MOVING, efficient snow plow that does not require extra casting wings is now being produced by Balderson Inc., Wamego, Kansas, manufacturer of auxiliary equipment for Caterpillar machines. Designed for use on the Cat 966 Traxcavator, the BV966 plow has easy-pushing moldboards, with a smooth conically-formed curvature that practically eliminates the need for extra sidewings. It attaches easily in place of the



BV966

bucket, making the Traxcavator ideal for opening streets and highways as a snow plow, aside from its standard use as a loader in removal of snow by trucks. Other features include: replaceable cutting edges and nosepiece, adjustable shoes, and special bracing that increases plow strength without reducing speed and efficiency with overweight construction. **—CE-36**

Ball Mill Motors

FIVE LARGE BALL MILL motors supply power to crush and grind enough raw materials and clinker to meet the demands of Dundee Cement Co.'s six million barrel a year capacity plant. The 2500 hp synchronous motors, manufactured by General Electric Co.'s Large Motor and Generator Dept., Schenectady 5, N.Y., feature across-the-line starting and ultra slow spotting equipment. Despite the size and weight of the ball mills, the spotting equipment and motors can line them up at any angle to load or unload the thousands of metal balls which add tons to the over-all weight. The system makes the machine operator's job less exacting and saves wear and tear on the motors. Full voltage, AC power is used for normal starting and operations. For spotting, the motors are switched to allow the use of DC which, in effect, allows an ultra low frequency of about one per cent of the normal operating speed for the accurate positioning of the mills. **—CE-37**

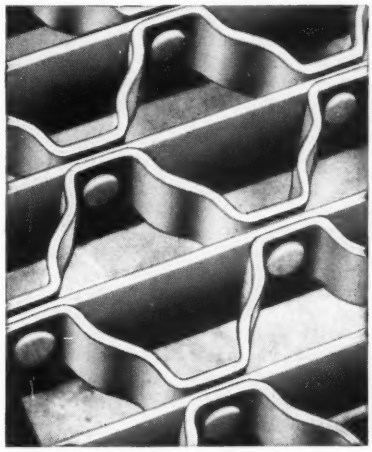
Pipe Turning Mechanism

A NEW PIPE TURNING MECHANISM has extended the life of taconite tailings pipe and speeded turning operations. Because of rapid abrasive wear on tailings pipes, most taconite plants turn pipe periodically so that it wears over a longer span and at a more even rate. The new device attaches to a front end loader at the fork ends and, by means of a ratchet and pawl arrangement, holds the pipe in place while turning it. Manufactured by Lake Shore, Inc., Iron Mountain, Mich. the device handles lengths up to 1200 ft. The ratchet fitting attaches to the pipe at the flange with the aid of an alloy pin through a single bolt hole. Pipes may be turned at one-quarter turn increments rather than the usual one-third turn thus giving users four pipe wearing surfaces instead of three. The device can be adapted to most front end loaders and is easily adjusted to fit a variety of pipe diameters. **—CE38**

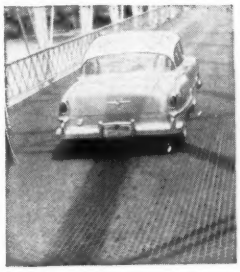
Economical Instruments

A LINE OF INSTRUMENTS featuring compact size and light weight is now produced by David White Instrument Div., Realist, Inc., Menomonee Falls, Wisc. The new instruments, called the Continental No. 8040 Level-Transit and the Continental No. 8050 Level, offer builders, contractors, masons, architects, excavators and landscapers an accurate, simple to use instrument at a budget price. Both are constructed of die cast high strength aluminum alloy with smooth enamel finish. Leveling plates are chrome plated and have a permanent built-in wick lubricating system. The circle rotates for zero settings and reads to degrees. The instruments have 8x power telescopes with micrometer ring focusing. **—CE-39**

New "CK" BRIDGE DECKING ENDS WEAVING OF CARS



Modification of the original Irving Type V Decking has eliminated "weaving" on open mesh steel floors. The improvement is effected by a 3/16" elevation difference of the crimped bars over the straight bars.



"CK" Decking, successfully field-tested for 4 years, has the same advantages of safety, strength, durability and self-maintenance as standard Type V Decking

Write for Complete Information on New "CK" DECKING.

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Literature Available

CRAWLER CRANE-EXCAVATOR—A catalog illustrating and describing the new 900 Series Crawler Crane-Excavator is now available from American Hoist & Derrick Co., 63 South Robert, St. Paul, Minn. The air-controlled crawler is in the 3½ to 4½ cu yd class. It has a rated lifting capacity of 110 tons, and is capable of handling boom lengths to 270 ft, plus jibs. Company officials say that an 18-in. ground clearance makes it the highest clearance machine of its size. They also assert that it is the easiest and quickest to prepare for transport because only four bolts need be removed, one at the end of each axle, in order to slide off the side frame. **—CE-40**

ELEVATED STEEL STORAGE TANKS—A new, 20-page brochure describing the design and function of elevated steel tanks for water storage is now available from Chicago Bridge & Iron Co., 332 So. Michigan Ave., Chicago 4, Ill. The brochure places particular emphasis on spheroidal, radial cone and ellipsoidal tank designs in capacities ranging from 15,000 to 3,000,000 gallons. Illustrated with photographs of structures now in service, it also contains tables of standard capacities. **—CE-41**

PHOTODRAWINGS—A new graphics concept in which photography and line drawing are combined to obtain greater readability and accuracy at substantially lower cost than conventional engineering drawings is described in a 4-page bulletin from Photodrawing Group, Log-Etronics, Inc., 500 East Monroe Ave., Alexandria, Va. Assembly drawings, instruction manual illustrations, design modifications and maintenance instructions are discussed in terms of the specific advantages of the photodrawing approach. Bulletin B-10M3 also gives the step-by-step production of photodrawings. **—CE-42**

BEARING PILE SPLICER—The H-Beam splicer sleeve described in this bulletin from Associated Pipe & Fitting Co., 262 Rutherford Blvd., Clifton, N.J., provides continuous beam action in a piling composed of two or more pieces. The face of both joining beams touch so that the impact of the pile hammer is transmitted to the tip as in a continuous pile. The sleeve not only affords perfect alignment between the sections but provides additional structural support to reinforce the beam web and a portion of the flanges at the splice. **—CE-43**

FOUNDATION PILES—COBI cast-in-place piles are featured in this booklet from C.L. Guild Construction Co., Inc., 90 Water St., E. Providence, R.I. The benefits of these piles include the fact that they develop the maximum soil sustaining power, have the maximum resistance to settlement, are set firmly at the required depth, and have the highest possible uplift capacity. **—CE-44**

AUGER TOOLS—Bulletin 13, from Acker Drill Co., Inc., P.O. Box 830, Scranton 2, Pa., is entirely devoted to new tools and techniques in Auger boring and sampling. The latest information on hollow-stem augers is clearly presented. **—CE-45**

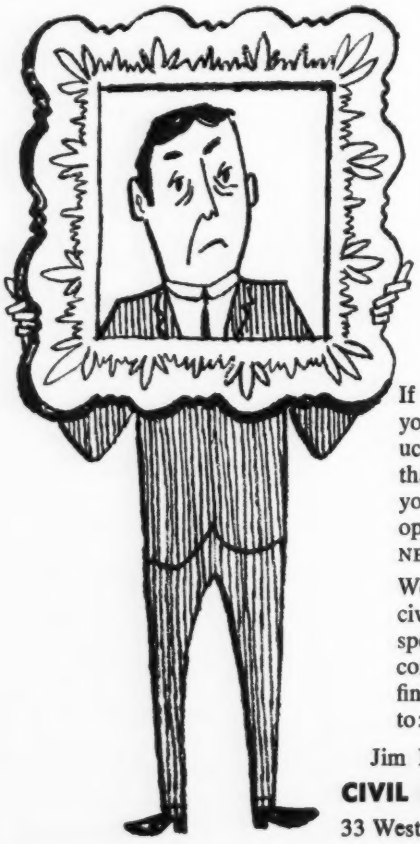
WATER PROBLEMS—A kit is available from Johns-Manville Corp., 22 East 40th St., New York 16, N.Y., with a complete program for community leaders to help them jar public indifference, marshal popular support and enlist civic-minded citizens in water advancement plans and projects. Included are booklets, window posters, newspaper advertisements, radio and TV scripts, all slanted to the consumer to create a wider awareness of water problems. It is available to water utility managers and other interested parties. **—CE-46**

ATOMIC ENERGY—Accomplishments in design and construction of reactors here and abroad are presented in this bulletin from Allis-Chalmers Mfg. Co., Milwaukee 1, Wisc. Also included is information on the many resources and services which the company's Atomic Energy Division can provide along with a discussion of the division's technical personnel and research and production facilities devoted to atomic energy problems. **—CE-47**

BACKBONE OF CONSTRUCTION—That aggregates are an extremely important and growing part of the construction materials business is the point made in a survey recently completed by the American-Marietta Co., 101 E. Ontario St., Chicago 11, Ill. It is suggested that the annual output of crushed stone, sand and gravel will have to be doubled by 1975 to keep pace with highway construction. **—CE-48**

Please allow at least four weeks to process your requests.

STRESSRODS—The properties of high tensile alloy steel bars for use in Prestressed concrete are presented in this brochure from Rods, Inc., 706 Folger Ave., Berkeley 10, Calif. The Stressrods System provides many advantages to the engineer and contractor for reasons of strength, limited number of tendons required, compactness, ease of installation, stressing, anchoring, and grouting. **—CE-49**



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Model No. 3065: A new model with 7 interchangeable drawing point sections, each complete with airtight refillable ink cartridge. Comes in handy desk top container.

Model No. 3060: The regular Koh-I-Noor Rapidograph "Technical" Fountain Pen with self-contained automatic filling system, and pocket clip.

Write for Descriptive Literature

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Literature Available

LIGHTING STANDARDS—Included in this catalog on Round Tapered Aluminum Lighting Standards, from Kerrigan Iron Works Co., 11th and Herman St., P.O. Box 479, Nashville 2, Tenn., are new designs in both street and area lighting standard equipment with a good variety of arms to meet most any lighting problem. Traffic signal standards and brackets and mast arms for wood, metal pole and wall mounting are included. **—CE-50**

STEEL FRAMING—Availability of a new 48-page design manual containing a complete structural analysis of V-LOK framing has been announced by Macomber, Inc., Canton, Ohio. The system of interlocking steel framing is illustrated and explained with details on standard columns, girders and purlins, specific design considerations, design features for external and internal wind forces, seismic loads, and expansion joints. **—CE-51**

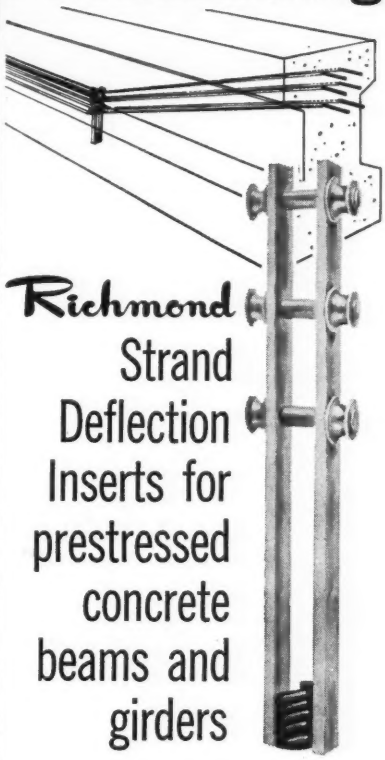
PRESSURE INJECTED FOOTINGS—The costs of excavations and shoring in cohesionless sand were eliminated on a recent construction job by the use of pressure injected footings supplied by Franki Foundation Co., 103 Park Ave., New York 17, N.Y. This bulletin describes how they were installed in the upper layers of the sand and gravel stratum overlaying a deep layer of soft clay. The uniform high compaction of the sand, due to controlled installation procedures, held to a minimum the possibility of differential settlement. **—CE-52**

BATCHING PLANTS—This brochure from The Heltzel Steel Form and Iron Co., Warren, Ohio, describes the self-erect mobile batching plant. Self-contained and easy to move, the fast set-up and large production capacities provide lower cost per cu yd of concrete produced. It enables the producer to offer on-the-job concrete for those small yardage jobs previously considered unprofitable. It is available as a Ready-Mix, Dry Batch, or Central Mix Plant. **—CE-53**

COMPUTER PROGRAMS—A list of programs in civil engineering that are available to users of the G-15 Digital Computer has been compiled by Bendix Computer Div., The Bendix Corp., Los Angeles 45, Calif. 11-pages long, it includes programs for traffic, surveying, earthwork, culverts and sewers, soils, interchange, bridges and piers, beams, columns, section properties, miscellaneous analysis, and hydraulics. **—CE-54**

VALVES AND FITTINGS—Ductile or nodular iron valves and fittings are now being marketed by Stockham Valves & Fittings, Birmingham 2, Ala. This booklet explains that ductile iron combines the strength, toughness and impact resistance of steel and the corrosion resistance of grey iron. The valves conform to ASTM, Coast Guard, and ASME Boiler Code specifications. **—CE-55**

Pretensioning



Richmond Strand Deflection Inserts for prestressed concrete beams and girders

Included in Richmond's complete line of inserts and accessories for prestressed concrete are a variety of strand deflecting devices, designed to accommodate ¾", 1" and 1¼" bolts or eye bolts to suit your project and match your pretensioning bench.

Richmond Strand Deflectors are manufactured for single, double and triple lines of strands and are available with or without keepers or rollers.

There is a standard line of Richmond Strand Deflection Inserts but, since requirements for deflecting devices vary widely, special units can be manufactured on request to suit individual needs.

For information about Richmond-engineered Strand Deflection Inserts for prestressed beams and girders contact us or our distributors: Intercontinental Equipment Co., Inc., 120 Broadway, New York 5, N. Y....and if you have a specific concreting problem, ask our Technical Department about it—they can help you. Write to:—

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HYDRAULIC DREDGING

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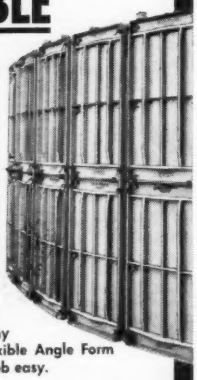
Gahagan Dredging Corporation, 90 Broad Street, New York 4, N. Y. Write, wire, or phone Whitehall 3-2558. Cable "Walgahagan".

EFCO FLEXIBLE Form Panels



Round concrete tanks or curved walls may be quickly formed by combining EFCO Flexible Steel Form Panels with regular EFCO Steel Forms.

For angles of any degree, EFCO Flexible Angle Form Panels make the job easy.

ASK FOR COMPLETE INFORMATION

ECONOMY FORMS CORP. EFCO ECONOMY FORMS

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Please send catalog showing EFCO Flexible and Regular Form Panels, and address of nearest sales office.

Name.....

Firm Name.....

Address.....

City.....State.....

Films Available

TS-14 SCRAPER—A 12-min, 16mm motion picture in sound and color, illustrating the versatility and operation of the 14-yd struck capacity All-Wheel Drive Model TS-14 Scraper, is announced by Euclid Div., General Motors Corp., Cleveland 17, Ohio. The film stresses how this "little twin" brings big job efficiency to small and medium sized jobs, broadens work scope, lengthens the working season, reduces equipment needs, and in many cases competes effectively with larger scrapers. **—CE-56**

APPLICATION OF PRODUCTION MACHINES—A visual demonstration of a variety of automatic machines is the subject of this 20 min, color, sound film from Gardner-Denver Co., Quincy, Ill. Emphasis is placed on increased production at greatly reduced costs. Utilizing compressed air, a variety of air tools, indexing and a minimum of manpower, these machines perform operations in seconds that formerly required much more time and energy to produce. **—CE-57**

"HOW TO BUILD NEW SHAPES IN CONCRETE"—Released by the Portland Cement Association, 33 West Grand Ave., Chicago 10, Ill., this 16mm sound-and-color film surveys several of the techniques employed in the construction of concrete shell roofs. In 19 min it describes many of the popular shell forming developments, including: movable forms, lightweight scaffolding, precast and earth forms. It also treats the use of prestressing in shell design and the use of shells in lift-slab buildings. **—CE-58**

"AIRWAYS TO FAIR TAXES"—This 20-min color-sound movie describes how detailed aerial tax maps are used by tax assessors in their work. Released by Aero Service Corp., 210 East Courtland Street, Philadelphia 20, Pa., it covers step-by-step production of aerial tax maps from aerial photography to preparation of base maps, microfilm deed records, property record cards, and final tax map compilation. It shows how these maps can help pave the way for accurate and up-to-date tax equalization programs. **—CE-59**

To obtain more information about these products please turn to page 112.

"IDEAL TRANSPORT STORY"—From Link-Belt Co., Dept. LBN, Prudential Plaza, Chicago 1, Ill., comes the story of Ideal Cement Company's 5½-mi overland belt conveyor system at Ada, Oklahoma, from land surveys through construction to full operation told in a 16 mm color film. It runs 22 minutes. Another film, "Preparation Makes the Product," tells the story of push-button coal cleaning in a large, highly automated coal preparation plant. It runs 19 minutes. **—CE-60**

TIDE GATES

Figure B-175. Type M-R Gates designed especially for application to centrifugal pump discharge lines. A rubber seating ring is inserted in the seat to absorb the slap which occurs when pumps stop. A flexible bar connection is arranged between the hinge links to provide a stop for the gate shutter to prevent the outer edge of the shutter from tipping downwardly when flow abruptly ceases. Smaller sizes of gate are provided with a bumper arrangement to prevent the shutter being forced too widely open when flow starts.

Ask for Bulletin 73A

BROWN & BROWN, INC.

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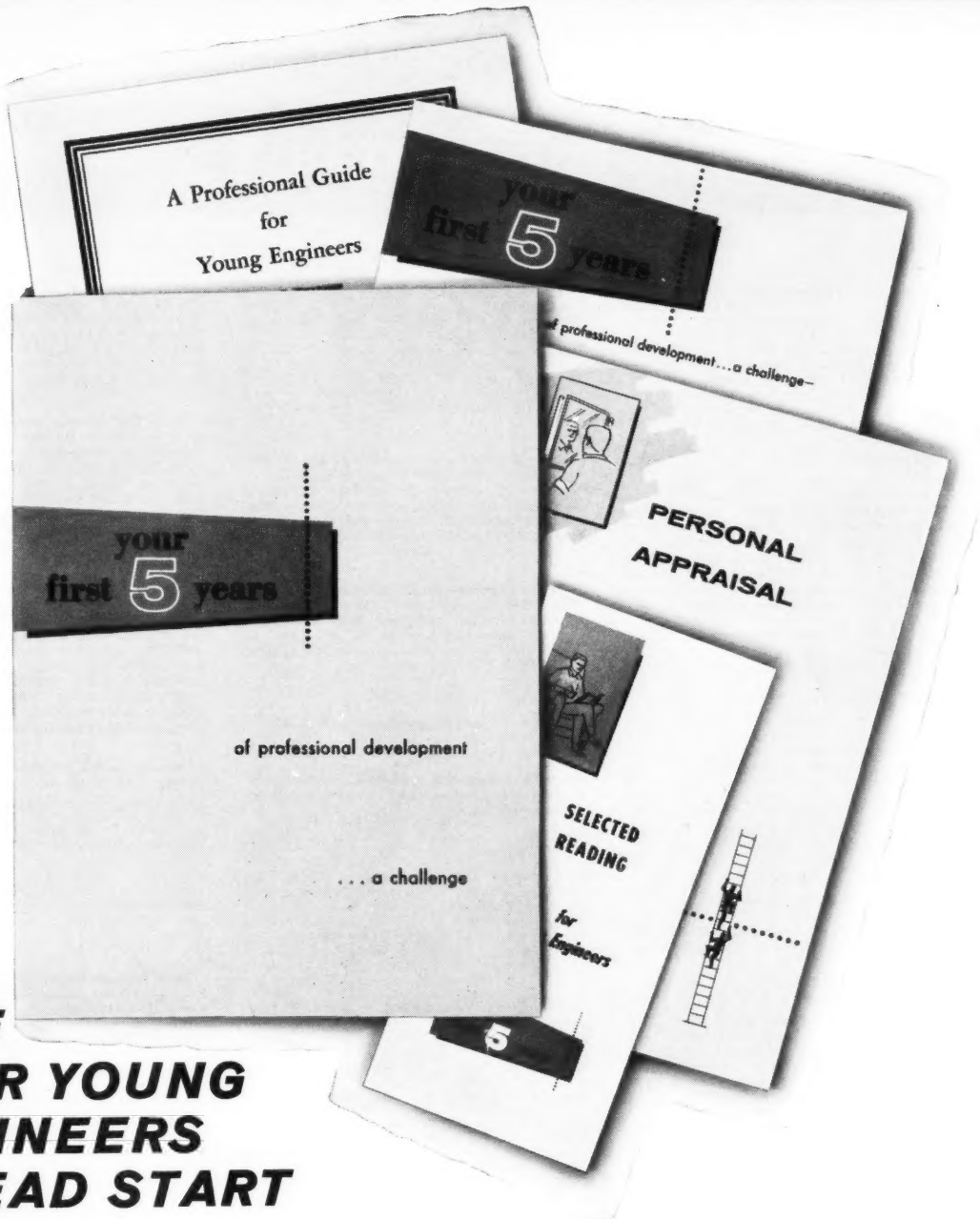
"FLOAT YOUR TROUBLES AWAY"—The heavy media process for removing unsound or deleterious particles from gravel is shown in this color film. Released by WEMCO, a div. of Western Machinery Co., Sales Promotion Dept., 650 Fifth Street, San Francisco 7, Calif., it presents the theory, operation and results, obtainable in producing premium aggregate by the HMS process, with case histories at three plants, two in the Midwest and one on the Pacific Coast. Also available is the 16 mm, color film, "It's the Extra Jiggle That Counts," describing the history and theory of jigging, one of the oldest forms of mineral beneficiation, as well as the design improvements embodied in the modern Remer Jig. Detailed scenes show modern-day jig treatment of iron ore on the Mesabi Range and at Eagle Mountain, Calif. The jigging of concrete aggregates at several mid-west sand and gravel plants is also shown. **—CE-61**

"INDUSTRIAL GASES AND SHIELDED ARC-WELDING"—A 16mm film featuring recently developed welding equipment and techniques has been issued by Air Reduction Sales Co., A Division of Air Reduction Co., Inc., 150 E. 42nd St., New York 17, N.Y. In full color and sound, the 27-min production correlates the story of industrial gases—oxygen, nitrogen, hydrogen, argon and carbon dioxide—with welding applications. The major part of the film features the uses of these gases in Heliweld, Aircospot and Aircomatic equipment. **—CE-62**



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PROCEEDINGS AVAILABLE

November

2661. Simple Rules for Hot or Cold Weather Concreting, by John J. Manning. (CO) This article is prepared for ready reference by field forces in connection with concreting operations during hot or cold weather. It is a concise outline of the procedures for placing and curing concrete during periods of sub-normal and above-normal temperatures.

2662. Construction of Rocky Reach Hydroelectric Project, by W. N. Evans and J. H. Boyd. (CO) Rocky Reach Dam was built in areas protected by beams and circular sheetpile cells, as much as 75 ft high, installed to rock through boulders. The million cubic yards of concrete were made from locally available gravel by four 2 cu yd tilting mixers; it was transported in 4 cu yd buckets on semi-trailers to big whirler cranes on 100-ft high gantries for placing in heavily-built panel forms. Rock bolts were used to tie down a section of the dam in which fault planes were encountered.

2663. Derivation of Flow Equations for Sewage Sludges, by Vaughn C. Behn, (SA) This paper has been prepared to bring together the solution of equations that have been derived by others and reported in various texts, journal articles, and theses. The extent of coverage is limited to time-independent, non-Newtonian liquids flowing in capillary and rotational viscometers and smooth pipes.

2664. Discussion of Proceedings Paper 2358, 2483, (CO) Clara F. Derrington on 2358. Robert F. Borg on 2483.

2665. Discussion of Proceedings Paper 2018, 2311, 2335, 2339, 2639, 2429, 2438, 2449, 2452, 2469, 2478. (HY) Ralph W. Powell and Chesley J. Posey on 2018. N. Claes H. Fisherstroem on 2311. Ivan J. Moskvitinoff on 2335. F. F. Linaweaver, Jr., John C. Geyer, and Jerome B. Wolff on 2339. D. V. Joglekar, W. J. Bauer, L. J. Tison, S. V. Chitale, A. Ryland Thomas, Mushtaq Ahmad, and Fier Luigi Romita on 2639. Samuel A. Greeley on 2429. Harold G. Golden and I. L. Trotter, Jr. on 2438. M. H. Diskin, Annabel L. Tong, K. M. Yao, and M. B. McPherson and J. V. Radziul on 2449. T. Blench on 2452. Praxtitelis A. Argyropoulos on 2469. Bernard L. Golding on 2478.

2666. Discussion of Proceedings Paper 2408, 2411, 2472, 2479. (SA) J. M. Jordaan, Jr. on 2408. M. T. Garrett, Jr. on 2411. Robert V. Thomann, M. B. McPherson, and C. H. J. Hull on 2472. Samuel A. Greeley and C. Y. Hitchcock on 2479.

2667. Discussion of Proceedings Paper 2221, 2428, 2433, 2461, 2470, 2541. (ST) John Sherman on 2221. Warner Lansing on 2428. J. Lieblein on 2433. James R. Krusling on 2461. Paul G. Fluck and Floyd E. Schneider on 2470. Phillip L. Gould on 2541.

December

Journals: Engineering Mechanics, Highways, Irrigation and Drainage, Soil Mechanics and Foundations, Structural.

2668. Stress Analysis of Rigid Frame Bridge with Inclined Legs, by Shih-yuan Cheng. (ST) Methods of direct moment distribution applied to the rigid frame bridges with inclined legs are introduced in this paper. A simplified method for influence line analysis is derived from the anti-symmetric loading condition formulas.

2669. Vortex Tube Sand Trap, by A. R. Robinson, (IR) Tests were made on a device that can be used for the removal of large sediments from canals. This material must be traveling as bed load in order to be trapped by the tube. Data from several investigations have been combined to develop general design information.

2670. Solution of Pressure Distribution Problem by Digital Computer, by U. W. Stoll. (SM) A general computer method for solving vertical pressure distribution in applied soil mechanics is presented in an attempt to retain a direct equivalence between the physical problem and the required computer notation and logic.

2671. Los Angeles Water Supply and Irrigation, by Samuel B. Morris. (IR) Los Angeles California imported new water supplies 240 miles and expanded its irrigated areas to afford early use for its aqueduct capacity. Irrigation caused replenishment of groundwater, increasing the city's water supply and the irrigator has paid only about one-half the cost of the water served him.

2672. Method for Estimating Consumptive Use of Water for Agriculture, by Wendell C. Munson. (IR) This paper presents data on measured rates of consumptive use of water as well as estimated consumptive use determined by various formulas; it describes a procedure for determining monthly and annual water requirements, on a project basis, from climatological data for areas in which measurements of consumptive use are not available.

2673. Irrigation Systems of the Tigris and Euphrates Valleys, by Stanley S. Butler. (IR) The high potential for irrigation and the fluctuations in the status of actual development during the sixty centuries of irrigation in the Tigris and Euphrates valleys of Iraq are described. Increases in income since 1951, from oil production, made it possible to accelerate design and construction of dams, canals, and deep wells and to start a drainage program with American engineers and construction firms participating.

2674. Movements of a Cable Due to Changes in Loading, by James Michalos and Charles Birnstiel. (ST) A numerical method is presented for the determination of displacements along a suspended cable resulting from change in load. The effect of elastic deformations is included. The procedure is particularly suitable for programming for an electronic digital computer.

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(SM) Soil Mechanics and Foundations
(ST) Structural
(SU) Surveying and Mapping
(WW) Waterways and Harbors

PROCEEDINGS AVAILABLE

2675. Plastic Analysis of Shallow Conical Shells, by E. T. Onat. (EM) A complete solution is obtained for a rigid plastic, simply supported shallow conical shell loaded through a rigid central boss in which one is enabled to assess the effects of changes in geometry on the load carrying capacity of a circular plate.

2676. Drainage, a Vital Need in Irrigated, Humid Areas, by Albert L. King. (IR) The use and importance of drainage and supplemental irrigation in solving problems created by rainfall patterns in irrigated, humid areas is discussed; where supplemental irrigation is practiced, drainage is as important a factor as the provision of water for crops.

2677. L T S Design of Continuously Reinforced Concrete Pavement, by Benjamen F. McCullough and William B. Ledbetter. (HW) This paper is aimed at presenting a rational and uncomplicated approach to the approximate design of continuously reinforced concrete pavement considering all the factors and variables that can be evaluated by means of available engineering tools.

2678. Concepts of Structural Safety, by C. B. Brown. (ST) This paper presents methods of providing engineering safety and additional safety necessary for social purposes. Ratio, probability, and combined ratio and probability are considered. Functional and collapse failure and the concept of structural life in design are discussed.

2679. End-Fixity Effect on Vibration and Instability, by David Burgreen. (EM) A study is made of the effect of arbitrary elastic end-fixity on the instability of columns and on the frequency of vibration on beams in which the significance and influence of negative end-fixity on buckling and vibration is examined. Simple expressions relating instability load and frequency of vibration to end-fixity are proposed.

2680. Periods of Framed Buildings for Earthquake Analysis, by Mario G. Salvadori and Ewald Heer. (ST) The shear, bending, rocking, and translational periods of cantilever beams with linearly varying shear and flexural rigidities, and with or without a concentrated mass at their top, are computed and combined to obtain a formula for the approximate evaluation of periods of framed buildings.

2681. Tuttle Creek Dam of Rolled Shale and Dredged Sand, by K. S. Lane and R. G. Fehrman. (SM) This paper covers the earthwork and foundation aspects of the project of which the more unusual features are closure "in the wet" and the handling of weak clay foundation partially by excavation and partially by exceptionally wide berms. Included were major volumes of shale-limestone constructed as a rolled fill and sand deposited by dredging into place two types of fill not commonly used in present-day earth dam construction.

2682. Humid Zone Irrigation in Ceylon, by Philip P. Dickinson. (IR) The development of irrigation in humid Ceylon through the centuries up until today (1960) is discussed. A major problem is the abnormal duty of irrigation water for rice culture.

2683. Dewatering the Port Allen Lock Excavation, by Charles L. Mansur and Robert I. Kaufman. (SM) This paper explains the functions of thirty-six large diameter deep wells that were installed around the top of the excavation for Port Allen Lock for the purpose of lowering the hydrostatic head in the deep stratum of previous sand that lies beneath the lock.

2684. Stress Conditions in Triaxial Compression, by A. Balla. (SM) A new solution is developed for the stress conditions of a cylindrical test specimen with any length-diameter ratio and subjected to axial and radial external loads.

2685. Climate and Crops in Humid Areas, by J. A. Riley and P. H. Grissom. (IR) The different aspects of climate as important influences on designing engineering procedures for increased farm efficiency and their effect on crops in humid areas are discussed.

2686. Brittle Fracture, by B. L. Averbach. (EM) The correlations between theories and experiments on brittle cleavage fractures in iron are developed herein.

2687. Ductility and the Strength of Metallic Structures, by J. M. Frankland. (EM) The need for the designer to consider ductility as an important factor in his design and to assume it to be implicit in his design is emphasized in this paper. The history of design prior to the discovery of mild steels is mentioned together with the early arguments of elastic versus plastic design. The meaning of ductility and the factors that may affect its testing are enumerated.

2688. Fatigue of Structural Materials, by Horace J. Grover. (EM) The current state of knowledge about the fatigue properties of structural materials is reviewed. The progress being made, in the case of metallic alloys, toward relating fatigue damage to behavior of dislocations in the crystalline lattice is enumerated.

2689. Metallurgical Advances and Civil Engineering, by Glenn Murphy. (EM) Emphasis is placed on the applicability of materials studies to all phases of civil engineering. Preceding papers of the symposium are commented on, and the historical aspects of materials studies are noted as well as the need for new studies to clear up areas of confusion.

2690. Elasto-Plastic Analysis by Numerical Procedures, by Annabel L. Tong. (EM) An elasto-plastic analysis for the bending and buckling of prismatic and structural members by numerical procedures is presented. A stress-strain diagram composed of two straight-line segments is used to approximate the actual stress-strain diagram of the material, simplifying the computations and giving reasonably good accuracy for materials having defined stress-strain diagrams.

2691. Discussion of Proceedings Paper 2197, 2199, 2497, 2500, 2502, 2505, 2516. (EM) G. N. Bycroft, M. J. Murphy, and K. J. Brown on 2197. William A. Bradley on 2199. Edward L. Wilson on 2497. E. F. Masur on 2500. Iqbal Ali on 2502. L. F. Stephens on 2505. O. C. Zienkiewicz on 2516.

2692. Progress Report of the Joint ASCE-ACI Committee in Composite Construction. (ST) This progress report includes recommendations for the design of structures containing prefabricated beams acting compositely with a cast-in-place reinforced concrete slab. Beams made of precast reinforced concrete, of precast prestressed concrete, or of steel sections are included.

2693. Structural Model Analysis by Means of Moire Fringes, by A. J. Durelli and T. M. Daniel. (ST) The objective of this paper is to demonstrate the use of moire fringe in the measurement of displacements and rotations in structural models. The method gave results in satisfactory agreement with theory whenever such comparison was made. The techniques used are simple and inexpensive.

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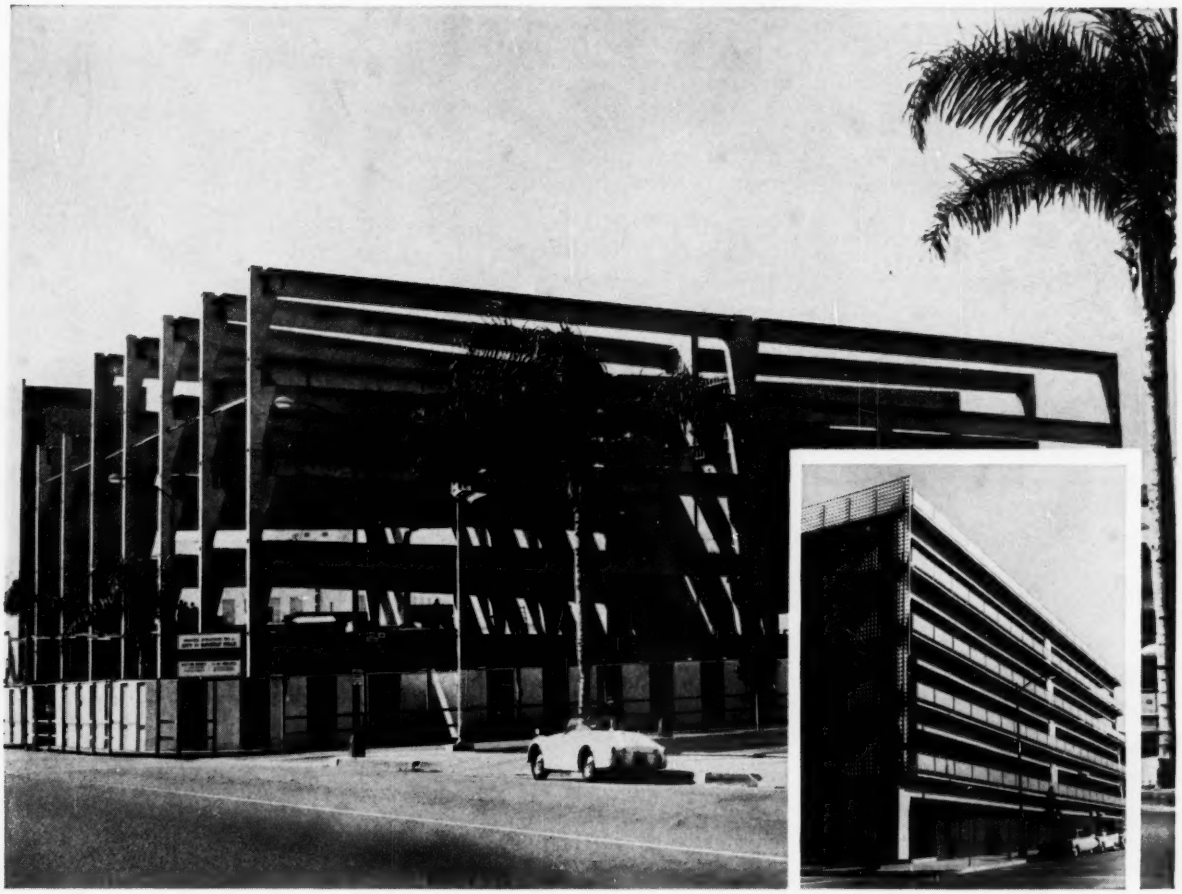

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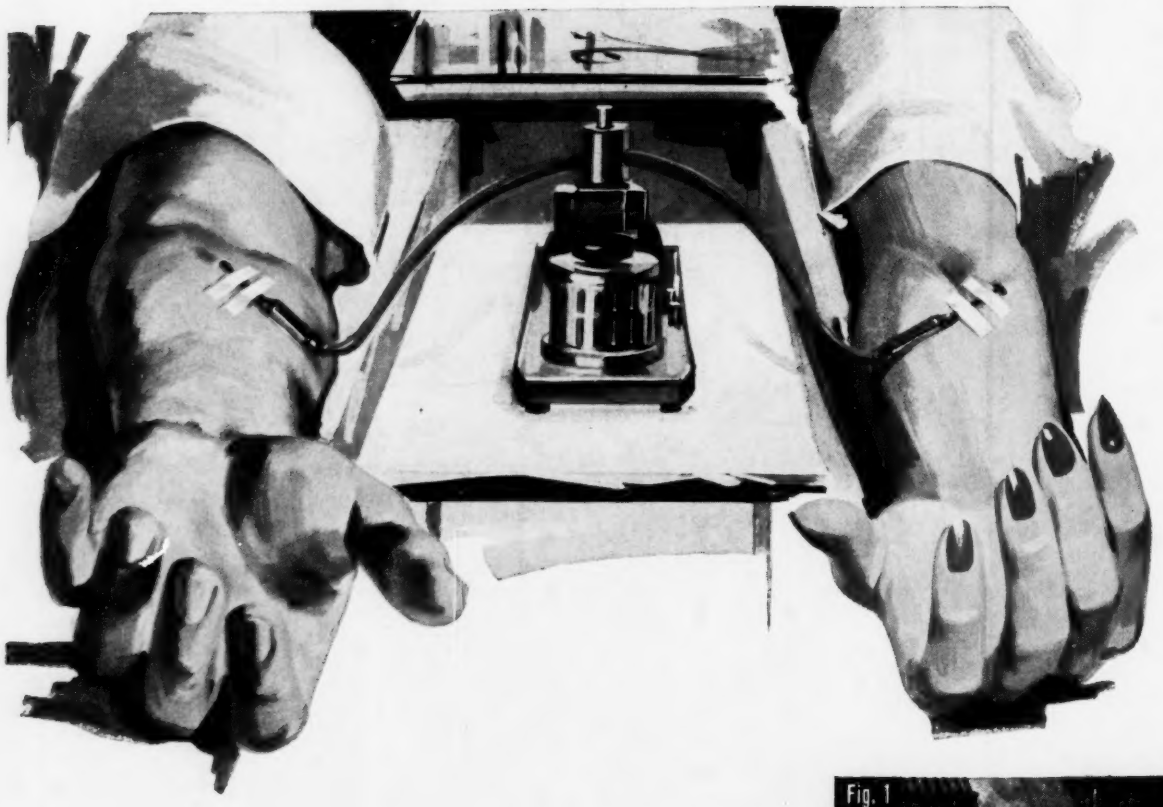

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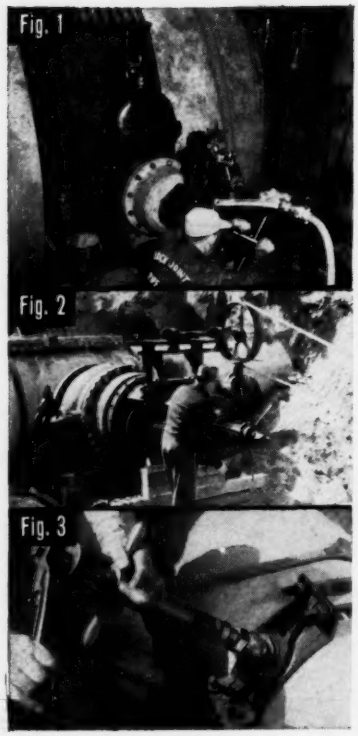

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